SPECIAL HANDLING

OPERATION AND MAINTENANCE MANUAL

GAMMA I RECTIFYING PROJECTION PRINTER

30 JUNE 1965

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Approved For Release 2003/05/15 : CIA-RDP78B04747A003200010022-9

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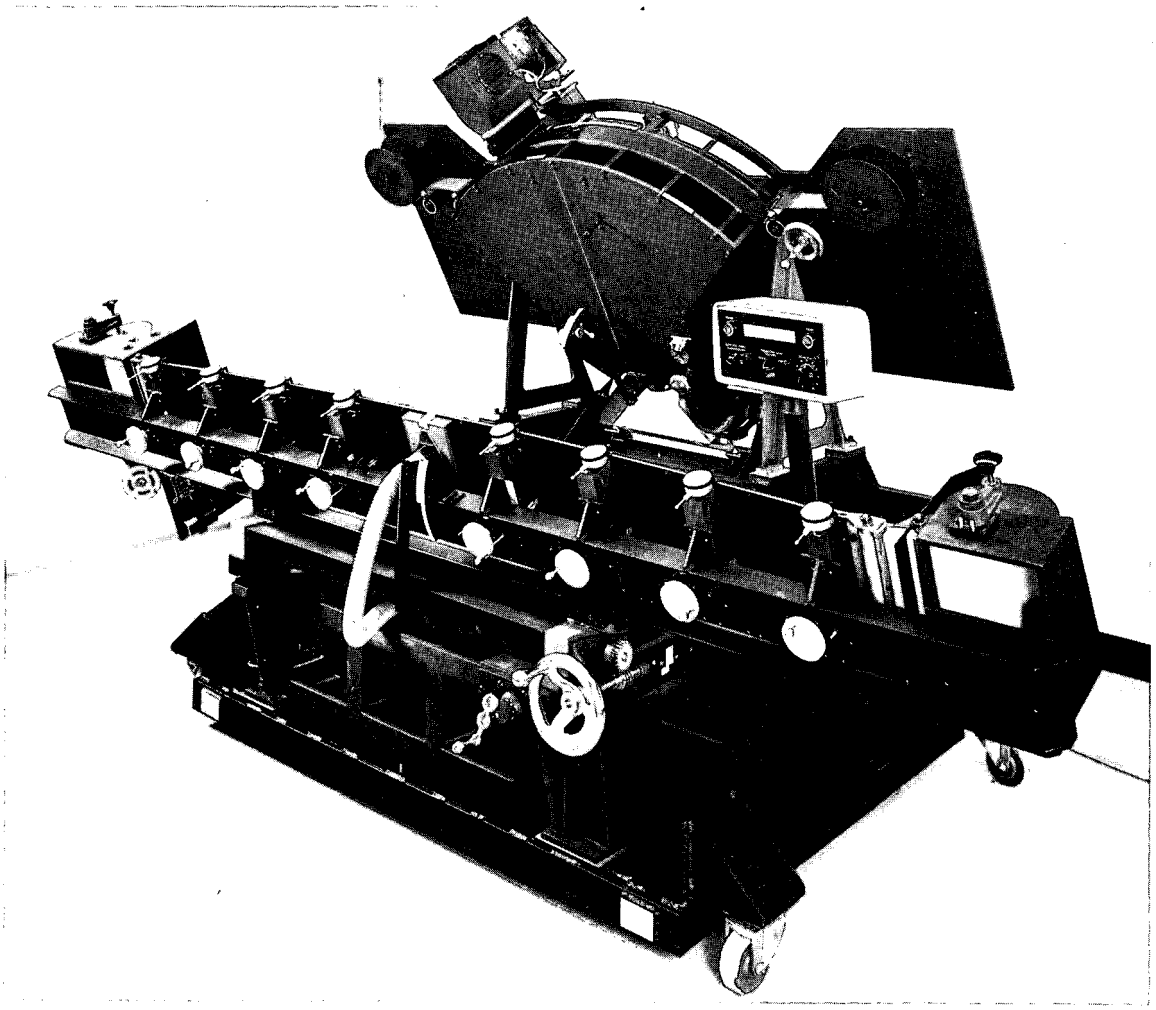

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Gamma I Rectifying Printer

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SECTION I

GENERAL DESCRIPTION

1-1. SCOPE.

1-2. This manual contains the operating and maintenance instructions for the Gamma I Rectifying Printer (see figure 1-1). Strict compliance with the methods and procedures outlined in this manual will ensure the proper use and service necessary for the continued satisfactory performance of the equipment.

1-3. PURPOSE AND USE.

1-4. The Gamma I Rectifying Printer is a compact, integral unit that transforms and rectifies distorted scale panoramic photography into enlarged, uniform scale, positive prints suitable for map and chart compilation and revision.

1-5. These prints are of normal photographic quality and exhibit no defects with respect to content, density, resolution, and general acceptability for photographic projection printing.

1-6. The printer is designed to duplicate proportionally the physical and dynamic aspects of the taking system but in a reverse manner, i.e., the light source sweeps peripherally about the panoramic film, projecting the images through the lens onto the copy easel.

1-7. OPERATING CHARACTERISTICS.

1-8. The copy easel, which simulates the earth in map scale, is cylindrically curved but with variable radii to simulate the apparent change in earth curvature as a function of altitude and camera tip angle. The easel may be inclined in order to simulate a tipped taking condition.

1-9. The film nadir may be centered on the rectifier geometric centerline, thereby eliminating the effects of camera roll.

1-10. The printer input material is 500-foot spools of 70-millimeter processed film containing negative panoramic imagery.

1-11. The printer output material is 500-foot spools of $9\frac{1}{2}$-inch-wide type 5427 Aerographic Duplicating film. The output copy film is exposed with rectified positive images of the input material during operation.

1-12. TECHNICAL CHARACTERISTICS.

1-13. The technical characteristics of the Gamma I Rectifying Printer are as follows.

a. Required power: 115 ± 10 volts, 60 ± 5 cps, 20 amperes, single phase.

b. Power consumption: 2,000 watts (including 500-watt projection lamp).

c. Printing light source: ASA type DFR, 500-watt, prefocused, locking 4 pin, projection lamp.

d. Lens: focal length 15.80 ±0.01 inches, f/12 (special design).

e. Positive film transport: motor drive, manual threading, automatic metering.

f. Negative film transport: constant tension, manual drive, manual threading.

g. Positive material.

STAT 1. [redacted] Aerographic Duplicating film, type 5427 (Military type 1A, class G2) on standard USAF 51C17848-12 spools.

2. Width: 9½ inches.

3. Length: 500 feet (maximum instrument capacity).

h. Negative film material.

1. Processed panoramic film on MS26565-5 spools.
2. Width: 70 millimeters.
3. Length: 500 feet (maximum instrument capacity).

i. Operational modes.

1. Single print: one print of selected frame on command.
2. Multiple prints: repeat single print mode as necessary.

j. Resolution capability: 80 lines per millimeter across the width of format at nadir; 50 lines per millimeter at a ±35-degree scan angle. These values are referred to the negative film and are in accordance with MIL-STD 150A.

k. Magnification: approximately 1.93× at nadir.

l. Weight: approximately 1,200 pounds.

1-14. COMPONENTS.

1-15. The major components of the Gamma I Rectifying Printer are (1) a light source and drive, (2) a negative stage, (3) a lens, and (4) a positive copy stage. A description of these components follows.

1-16. LIGHT SOURCE AND DRIVE. The light source (figure 1-2) comprises a projection lamp, two condensing lenses, an interference filter, and a cooling fan, all mounted on a rotating scan arm that sweeps along the curved negative stage to expose the film progressively.

1-17. A unique, varied velocity drive mechanism compensates for the light falloff caused by the constantly varying long conjugate dimension. This drive mechanism produces a uniform light-time product at all points along the copy plane.

1-18. NEGATIVE STAGE. The negative stage comprises a film platen, a film transport system, and a nadir offset device.

1-19. The film platen (figure 1-3) consists of a curved set of tracks that approximate the dimensions and configuration of the camera film plane. The tracks support the edges of the film in such a manner that the light beam can be projected through the film onto the lens.

1-20. The negative film transport is a manually controlled mechanism that mounts the input film onto the printer and allows the operator to translate film from a supply spool, along the film platen, and onto a takeup spool. A constant tension device precludes sagging or buckling of the film.

1-21. The nadir offset device (figure 1-4) consists of a scale and an adjustable indicator mounted parallel to the platen tracks. This device indicates the correct location for the film format nadir fiducial mark in terms of camera vehicle roll.

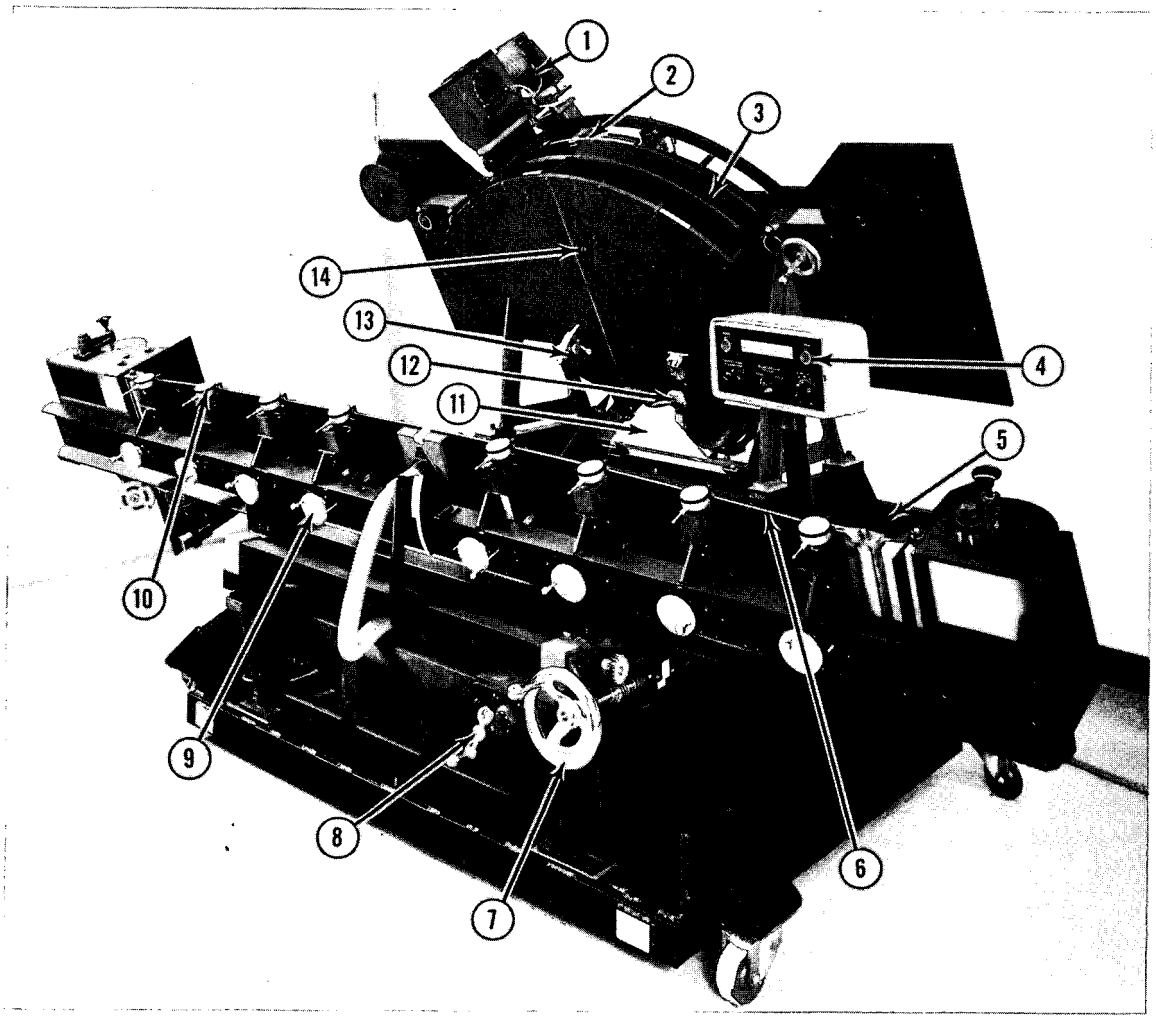
1-22. LENS. The projection lens has been designed and fabricated by [redacted] to meet the specific requirements of the Gamma I Rectifying Printer. The lens (figure 1-5) is mounted so that it is driven through its exposure scan by the scan arm drive at a differential angle to maintain constant focus at the proper scale. STAT

1-23. The mounting assembly has gimbal type suspension components to allow adjustment of the Scheimpflug angle to compensate for tilted photography. These components operate together with a focusing cam to compensate for the variations in projection distance induced by the adjustable tip and position of the copy easel.

1-24. POSITIVE COPY STAGE. The positive copy stage comprises a curved easel and a film transport system.

1-25. The easel (figure 1-6) has a manually variable curvature, and may be tilted about and translated along the centerline of the optical path. Its surface is grooved and coupled to a vacuum system so that atmospheric pressure holds the film tightly to the cylindrical easel configuration during exposure.

1-26. The copy film transport is a mechanical, unidirectional drive system that releases the vacuum and automatically drives the copy film a metered distance after the completion of each photographic exposure.



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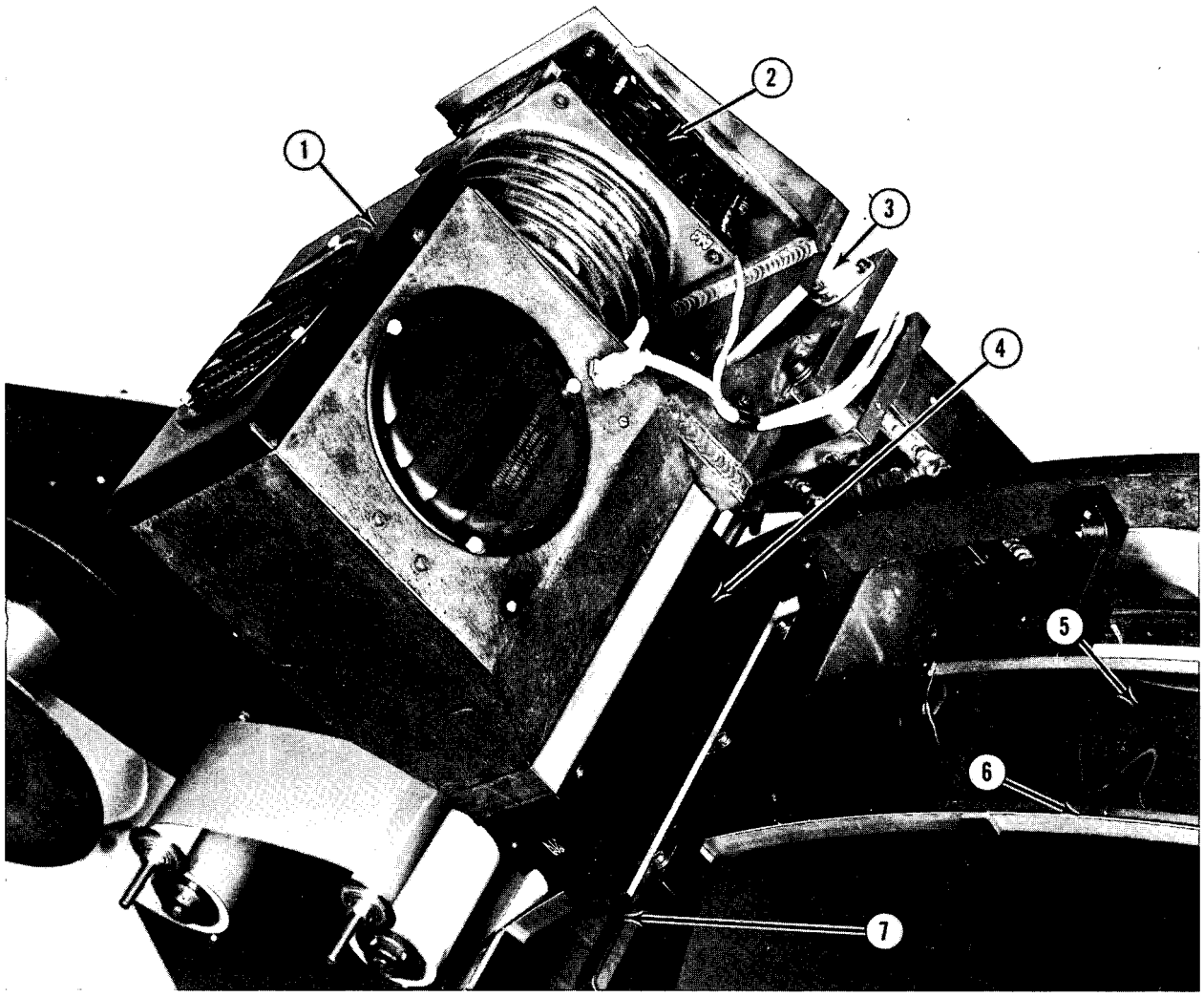
1	Light source	8	Easel translation control
2	Nadir offset device	9	Easel curvature control
3	Negative film platen	10	Easel curvature indicator
4	Control panel	11	Folding mirror
5	Control chassis	12	Focus control
6	Copy easel	13	Scheimpflug control
7	Easel tilt control	14	Viewing glow lamp lever

Figure 1-1. Gamma I Rectifying Printer



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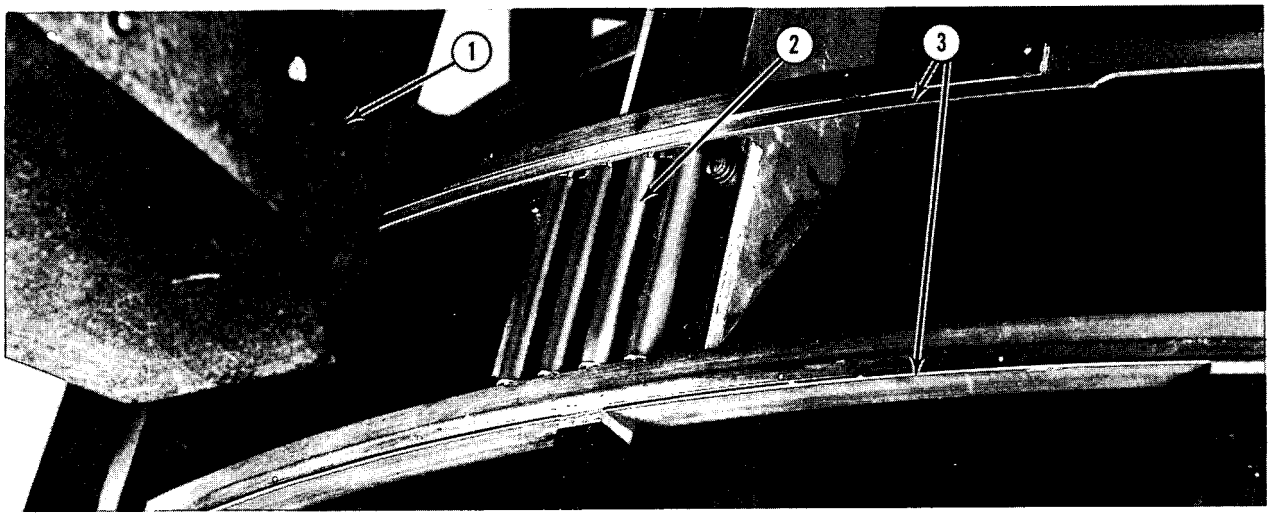
1 Light source housing
2 Cooling fan
3 Isolation mounts
4 Condenser housing
5 Negative input film
6 Negative film platen
7 Slit width control

Figure 1-2. Light Source and Cooling System



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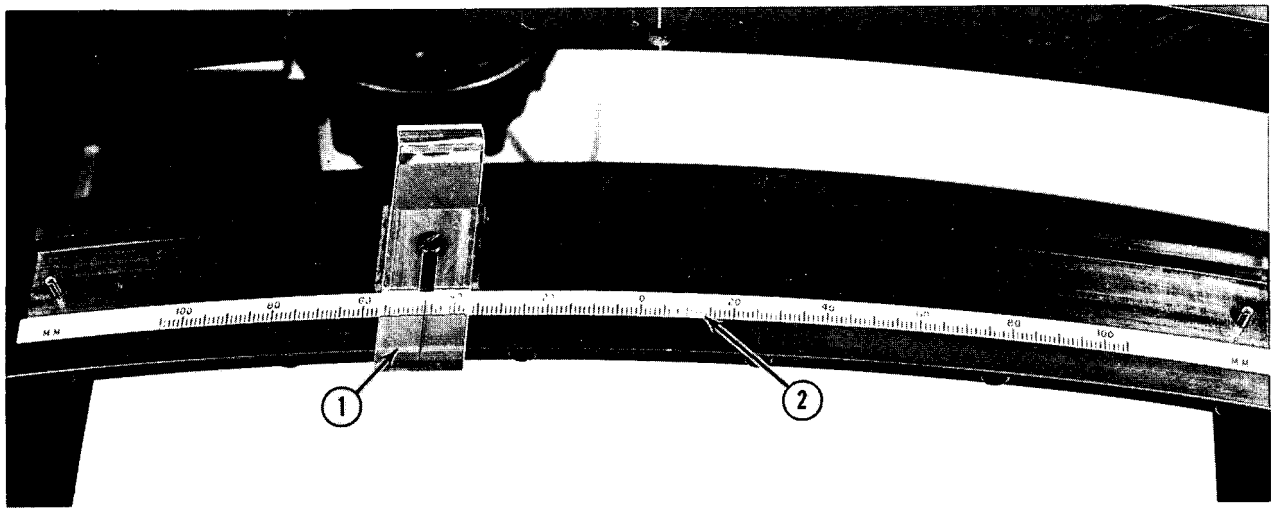
1 Light source
2 Film support rollers
3 Film tracks

Figure 1-3. Film Platen (Condenser System Removed)



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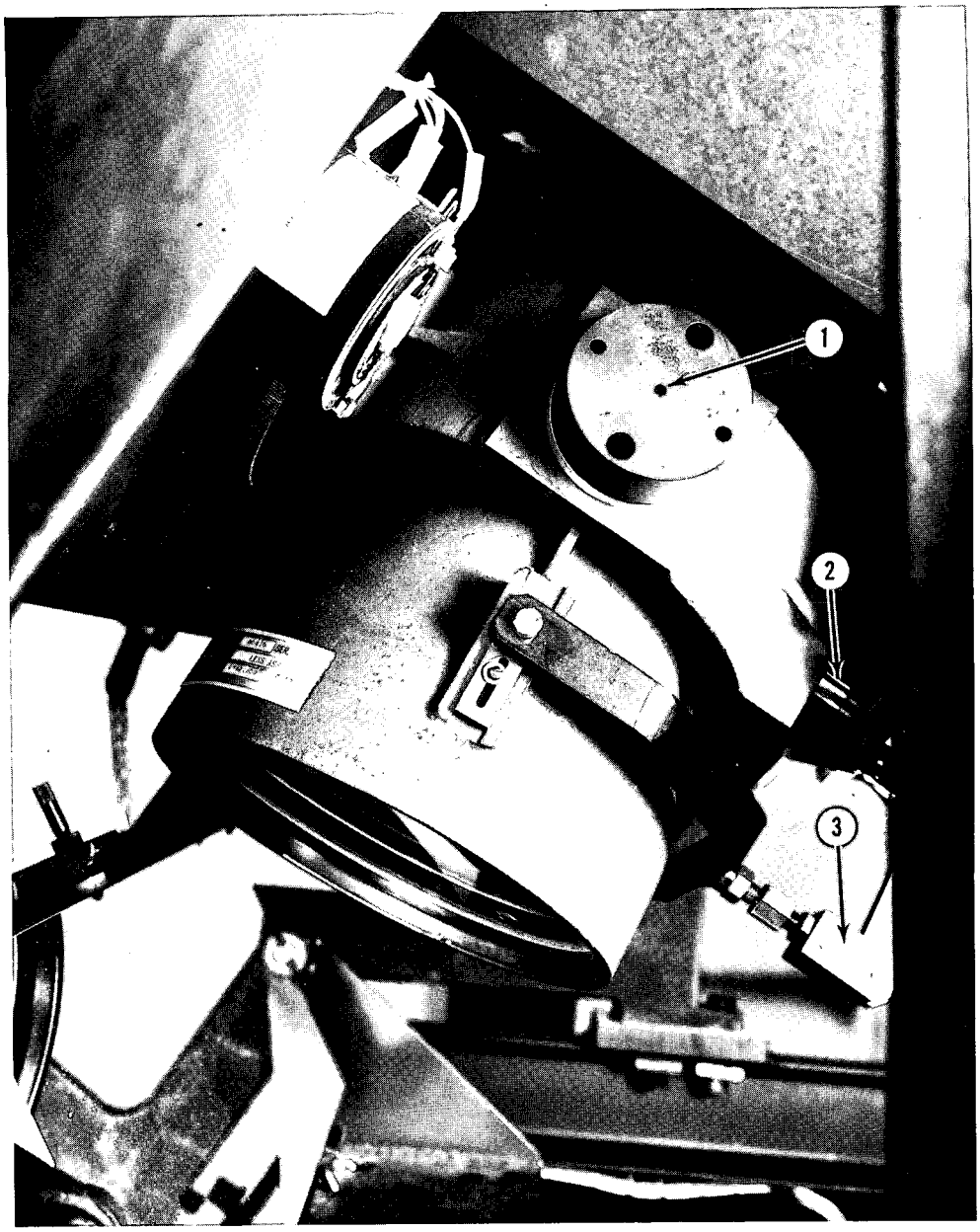
1 Nadir offset indicator
2 Nadir offset scale

Figure 1-4. Nadir Offset Device



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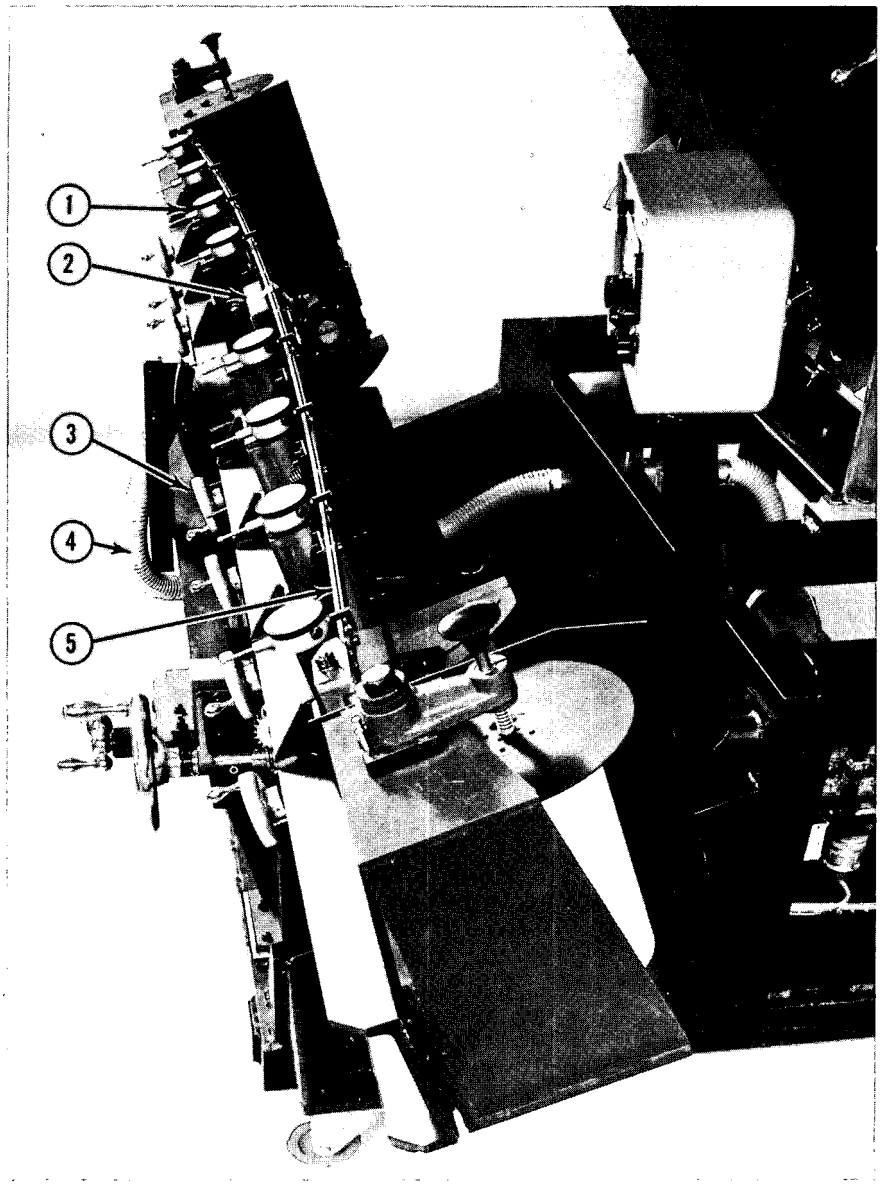
1 Scheimpflug axis
2 Focus control axis
3 Scheimpflug control linkage

Figure 1-5. Lens Assembly



1 Curvature indicator
2 Vacuum manifold
3 Curvature control
4 Vacuum hose
5 Copy easel

Figure 1-6. Copy Easel (Bend Represents Earth's Curvature)

SECTION II

THEORY OF OPERATION

2-1. GENERAL.

2-2. The Gamma I Rectifying Printer is constructed on a two-section, aluminum alloy framework solidly fastened together to form a single, rigid unit. All components and mechanisms are fastened to this framework.

2-3. The general configuration of the instrument is such that the optical path is folded at an acute angle. This places the light source (when centered on the negative film platen) and the center of the negative film plane at about the eye level of a standing operator.

2-4. The negative film platen is roughly perpendicular (in a left-right orientation) to the operator's line of sight, with the film tilted 30 degrees toward him.

2-5. The light source scan arm is positioned so that the light source is perpendicular to the film plane. This arrangement projects the light downward and toward the rear of the instrument.

2-6. A first surface mirror, mounted approximately parallel to the film plane (in the left-right attitude), intercepts the beam at approximately the height of a standing operator's knees. The mirror reflects the beam toward the operator to the copy easel in a plane parallel to the floor.

2-7. The copy easel may be positioned at angles of approximately −5 to +20 degrees to the central beam in the vertical attitude and parallel to the floor in the left-right attitude (figure 2-1).

2-8. Orientation of the input film is 30 degrees off horizontal, while that of the copy film is roughly vertical. The latter attitude may be modified by the variable tilt ability of the copy easel.

2-9. No external skin is provided, since the printer will be permanently mounted in a darkroom. This will allow convenient access to components.

2-10. PRINCIPLES OF MECHANICAL OPERATION.

2-11. Four principal systems provide the basic mechanical functions necessary to the operation of the printer. These systems are described in the following paragraphs.

2-12. NEGATIVE FILM TRANSPORT. Negative film is manually transported bidirectionally by means of a handwheel located on the front of the support plate at the operator's right (figure 2-2). The handwheel is geared to a driving sprocket through a push-pull, spring loaded mechanism. The action of the handwheel shaft operates a microswitch that controls a magnetic brake connected to the driving sprocket (figure 2-3). When the handwheel is engaged (pushed in), the brake is deenergized, and the sprocket drive may be rotated. When the handwheel is disengaged (pulled out), the brake is energized to prevent unwanted film motion. When the handwheel is pushed in, gears are engaged. Clockwise rotation of the handwheel causes the drive roller to move the film in a left to

right direction; counterclockwise rotation of the handwheel causes the drive roller to move the film in a right to left direction.

2-13. Tension on the film over the platen is maintained by a tension roller coupled to a torque motor (figure 2-4). The motor is connected electrically so that it applies a force to the film in a right to left direction to maintain tension when the drive roller brake is energized.

2-14. Film spindles are mounted at either end of the negative film platen so that the film runs from one spool (mounted on the spindle), over the platen assembly, and onto the other spool. Each spindle is coupled to a torque motor which winds the film onto its respective spool.

2-15. COPY FILM TRANSPORT. The copy film transport system (figure 2-5) comprises supply and takeup spindle assemblies, a drive mechanism, the copy easel, and guide rollers.

2-16. The spindle assemblies are mounted at either end of the copy easel with the supply unit at the operator's right and the takeup unit at his left. Each has a stub spindle equipped with brake drums. An adjustable, constantly acting band brake applies drag to its respective shaft. In addition to the drag brake, the takeup stub spindle is coupled through a bevel gear train to a torque motor whose rotation tends to wrap film onto the takeup spool.

2-17. The combination of drag brakes and takeup torque motor prevents film spillage by maintaining tension on the film in both the power on and power off conditions.

2-18. The copy easel serves as a film guide and support in the transport system. The easel, along with the film transport system, is mounted on a sliding carriage that allows translation along the projection axis. A conventional manual crank is used to translate the assembly as required to compensate for the tilt setting of the easel.

2-19. The drive mechanism consists of a neoprene covered drive roller, a drive motor, a gear train, and a variable speed control with a cam and switch timing arrangement. The drive system is designed to automatically transport film at the completion of each exposure cycle. Manual adjustment of the speed control will vary the length of film transported.

2-20. The guide rollers are free wheeling idlers located in the supply and takeup housings and at the ends of the easel to guide the film through the transport path and to provide a 270-degree wrap around the drive roller, thus ensuring positive drive.

2-21. SCAN ARM AND DRIVE ASSEMBLY. The scan arm and drive assembly (figure 2-6) consists of the drive arm, a drive motor, a drive track, V ways, an exposure control mechanism, travel limit switches, and a counterweight.

2-22. The drive arm is pivot mounted to the support plate of the main framework so that when the arm is rotated about the pivot point, the lamp housing swings through an arc concentric with the negative film platen. A spur gear, rigidly fastened to the arm at the pivot point so that it rotates at the same angular velocity as the arm, drives the focus cam control shaft and the exposure control.

2-23. The drive track is mounted on the rear surface of the support plate, perpendicular to the drive arm when the arm is in the nadir position. The track is spaced away from the plate so that the drive arm may swing between it and the plate.

2-24. The drive motor is on a movable carriage support that is mounted to the drive track by three guide wheels. A friction wheel is coupled to the shaft of the drive motor through a helical gear reduction unit. When the motor is activated, the carriage is driven along the track at a velocity dictated by the geometry of the mechanism and the variable speed of the motor.

2-25. The drive motor carriage is coupled to the sliding unit of the V way assembly, which is in turn fastened to the drive arm. As the carriage is translated along the drive track, it swings the arm through its arc by applying force at continuously varying radii. This serves to vary the arm velocity from minimum at the start of the swing to maximum at the center and then to minimum at the other end. This, in part, produces uniform exposure at the copy easel.

2-26. The limit switches at both ends of the drive track prevent overtravel and reverse the scan drive circuitry for the next exposure.

2-27. The exposure control consists of a drive gear, an idler gear, and a driven gear. The drive gear is fastened to the drive arm. The driven gear is coupled to the wiper shaft of a variable transformer that is electrically connected with the drive motor power line. As the arm rotates, the motor voltage is varied, further modifying the sweep velocity as required to produce uniform exposure at the copy easel.

2-28. A counterweight is fastened to the lower portion of the drive arm to balance the assembly.

2-29. VACUUM SYSTEM. The vacuum system (figure 2-7) consists of a turbine, the copy easel, solenoid control valves, an on-off switch, and interconnecting hoses.

2-30. The copy easel is constructed in two parts: the vacuum manifold casting, and the Teflon coated cover plate which contains the vacuum access grooves (figure 1-6).

2-31. The vacuum solenoids, which cycle the application and release of the vacuum, are connected to the easel manifold and the vacuum pump through plastic tubing.

2-32. The vacuum system creates a pressure differential between the surfaces of the copy film on the easel, thereby holding the film firmly against the curved surface of the easel during the photographic exposure. This pressure differential is achieved by withdrawing air through longitudinal grooves in the cover plate by means of the turbine.

2-33. An on-off switch is connected to the vacuum solenoid valve to override the automatic vacuum switching circuitry so that adjustments can be made to the copy film at the easel.

2-34. PRINCIPLES OF OPTICAL OPERATION.

2-35. The optical system of the Gamma I Rectifying Printer is centered in the projection lens assembly, which comprises the lens, the lens drive and focusing mechanism, the Scheimpflug adjustment mechanism, and a folding mirror.

2-36. PROJECTION LENS. The projection lens is specially designed and fabricated by [redacted] for the Gamma I Rectifying Printer. This lens, nominally f/12 at infinite conjugates, has a focal length of 15.80 ± 0.01 inches, and is essentially diffraction limited on axis at 4358 Å, the wavelength for which it is optimized. Proper spectral selection is accomplished by a narrow band interference filter in the condenser system. An adjustable iris diaphragm is included, but the iris must be set at f/12 for optimum performance. STAT

2-37. The nodal points and exit pupils are coincident with each other to obtain high resolution based on a flat field and minimum distortion. As a result, residual optical distortion is very low, having a magnitude of about 0.003 inch at approximately 15 degrees semifield angle.

2-38. The lens is mounted in a gimbal suspension assembly which is pivot mounted on the support plate coaxially with the scan arm and is free to rotate through the maximum scan angle. Inner and outer gimbals support the lens so that it has limited freedom to swing on two sets of trunnions. One set allows rotation about the Scheimpflug axis, the other about the scan axis. The assembly is driven about the pivot point with the lens attitude set by the Scheimpflug and focusing adjustments.

2-39. FOCUS CAM. A three-dimensional focus cam (figure 2-8) adjusts the angular position of the lens about the scan axis to maintain sharp focus throughout the effective scan angle of 80 degrees. The cam compensates for the change in projection distance that results from the rectifier geometry. The focus cam shaft is coupled to the scan arm through a spur gear so that it rotates proportionally with the arm. The lens assembly is thus rotated at variable differential velocities through the cam follower and the driving gear train.

2-40. SCHEIMPFLUG ADJUSTMENT. The Scheimpflug control (figure 2-9) positions the lens about the Scheimpflug axis (which is perpendicular to the scan axis) to the correct angle for the taking parameters of the individual frame.

2-41. FOLDING MIRROR. A folding mirror is located in such a manner that the projected light beam is reflected onto the copy easel at all lens and easel setting combinations.

2-42. PRINCIPLES OF ELECTRICAL OPERATION.

2-43. The electrical circuitry and components, with the exception of locally positioned motors, switches, and cables, are contained in the control chassis mounted in the main framework (figures 2-10 and 2-11).

2-44. This unit has quick disconnect electrical couplings so that it may be readily removed for service.

2-45. The input power to the printer is 115 ± 10 volts, single phase, 60 ± 5 cps, 20 amperes. Connection between the printer receptacle (J101) and the power source is made by means of the three-wire, neoprene covered line cord.

2-46. The following paragraphs contain a functional description of the sequence of events which occur during the normal operation of the printer. To clearly understand the operation of the printer and follow the sequence of events, reference should be made to the electrical schematic (figure 2-12) and to figure 3-1.

2-47. ENERGIZING THE SYSTEM. Depressing the POWER switch (S101) for printer operation energizes the power relay (K101) and supplies power to the 70-millimeter negative film transport system torque motors (B102, B103, and B104), the 9½-inch copy film transport system takeup torque motor (B101), the projection lamp cooling fan (B108), the vacuum turbine motor (B107), the 9½-inch copy film transport brake (L102-B), the 70-millimeter negative film transport brake (L105), the vacuum solenoids (L103 and L104), and the voltage reduction transformer (T101) which provides 6 volts for operation of the control panel and switch function lamps (DS101, DS102, DS105, DS106, and DS107). The level of illumination at the control panel is regulated by the CONTROL PANEL ILLUMINATION rheostat (R101).

2-48. VIEWING GLOW LAMP. Raising the viewing glow lamp (DS104) into position under the 70-millimeter negative film platen by raising the viewing glow lamp lever activates switch S107 which applies 115 vac across the lamp, and prevents the activation of a scan cycle until the lamp is returned to the stored position. The glow lamp illuminates the negative for viewing and positioning of the nadir offset indicator.

2-49. Pushing the negative film transport handwheel in to engage the drive gears activates the brake control switch (S111) which removes the voltage from the brake (L105), allowing the film to be transported until the fiducial marks are brought into coincidence with the nadir offset indicator. Releasing the spring loaded handwheel releases the brake control switch (S111) thereby reactivating the brake (L105) to maintain the position of the film.

2-50. The viewing lamp (DS104) is returned to the stored position by lowering the lamp lever.

2-51. Mechanical settings for Scheimpflug tilt, easel tilt, and easel translation conjugate as made from the slide rule settings (see paragraph 3-15) for the appropriate negative frame.

2-52. The PROJECTION LAMP VOLTAGE control (S103) will usually be set at NORM, which will allow 115 vac to be supplied to the projection lamp (DS103) during scan. Setting the control (S103) at HIGH will allow 135 vac to be applied across the projection lamp for use with especially dense negatives.

2-53. The SCAN TIME control (T105) is set for the negative to be exposed. This control varies the field voltage (and consequently the base velocity) of the scan drive motor (B106), resulting in an approximate 6:1 range of scan time.

2-54. Depressing the PRINT switch (S102) initiates a print cycle.

2-55. SCAN DRIVE. The optical configuration of the printer is such that the image distance is minimum at nadir, and increases to a maximum at either end. This configuration causes a light falloff that increases from nadir to either end. If the scan arm were rotated at a constant angular velocity, the print would be correctly exposed only at nadir, with constantly increasing underexposure toward either end of the frame. The inherent light falloff is compensated for by varying the angular velocity of the scan arm.

2-56. Two methods of scan speed control are applied to the driving mechanism to achieve a velocity curve that compensates for the light falloff. The scan arm is driven by means of a friction wheel connected to the scan drive motor (B106) so as to convert rotation to translation. The translation of the drive motor carriage along the drive track is transmitted to the scan arm through a sliding mechanism which applies a tangential force to the scan arm at constantly varying radii, thereby changing the arm's angular velocity so that it is minimum at the ends and maximum at nadir. In addition to the velocity variation induced by the sliding linkage mechanism, the exposure control actuated by the scan drive arm varies the armature voltage of the drive motor (B106). The scan arm is geared to a variable transformer (T102) which is connected electrically through a control rectifier (A104) in such a manner that the angular position of the scan arm determines the voltage impressed on the motor armature. Voltage (and consequently motor velocity) is minimum at the ends of the scan and increases to maximum at nadir, where the reference voltage impressed on the variable transformer is automatically switched by a cam actuated switch (S108) to control the decrease in voltage to the ends of the scan. The total scan angle is 90 degrees, which provides 5 degrees overtravel at each end of the scan to allow a controlled acceleration and deceleration rate to reduce mechanical transient vibration.

2-57. Limit switches located at the ends of the scan drive track (S105—left limit, and S106—right limit) signal the copy film drive when to transport after an exposure cycle. The relay circuitry turns the projection lamp (DS103) on and off at the beginning and end of an exposure cycle and energizes the vacuum solenoid valves and magnetic brakes.

2-58. NEGATIVE FILM TRANSPORT. The 70-millimeter negative film is manually transported, and may be positioned bidirectionally. A handwheel located on the right-hand front surface of the support plate drives two rollers through a gear and chain mechanism.

2-59. Film tension is maintained by a tension roller coupled to a torque motor (B102) which operates in a stalled condition except during transport. The amount of torque applied to the tension roller may be varied by changing the voltage impressed on the motor. This is accomplished by adjusting a variable transformer (T103) by means of the 70 MM TENSION control located on the

control chassis. This control is used to compensate for film characteristics and for environmental conditions.

2-60. A torque motor (B103) is coupled to the takeup spindle located on the left-hand side of the printer, and another torque motor (B104) is coupled to the supply spindle located on the right-hand side of the printer. These motors ensure film tension during operation, and prevent film from spilling during transport.

2-61. COPY FILM TRANSPORT. The copy film is automatically transported at the completion of each exposure cycle by means of a drive motor (B105) connected to the drive roller through a magnetic coupling (L102-A). When the scan arm activates either of its limit switches upon completion of an exposure cycle, the relay circuitry removes power from the drive roller brake (L102-B) and applies it to the coupling (L102-A) while simultaneously applying power to the copy film drive motor (B105).

2-62. The drive roller is geared through a speed control unit to the timing cams which activate the transport switches (S109 and S112). The cams make one revolution for every transport cycle.

2-63. Switches S109 and S112 signal the relay circuitry at the completion of a transport cycle. Power is then removed from the coupling (L102-A) and applied to the brake (L102-B). Power is also removed from the drive motor (B105), and the vacuum solenoid (L103) is energized.

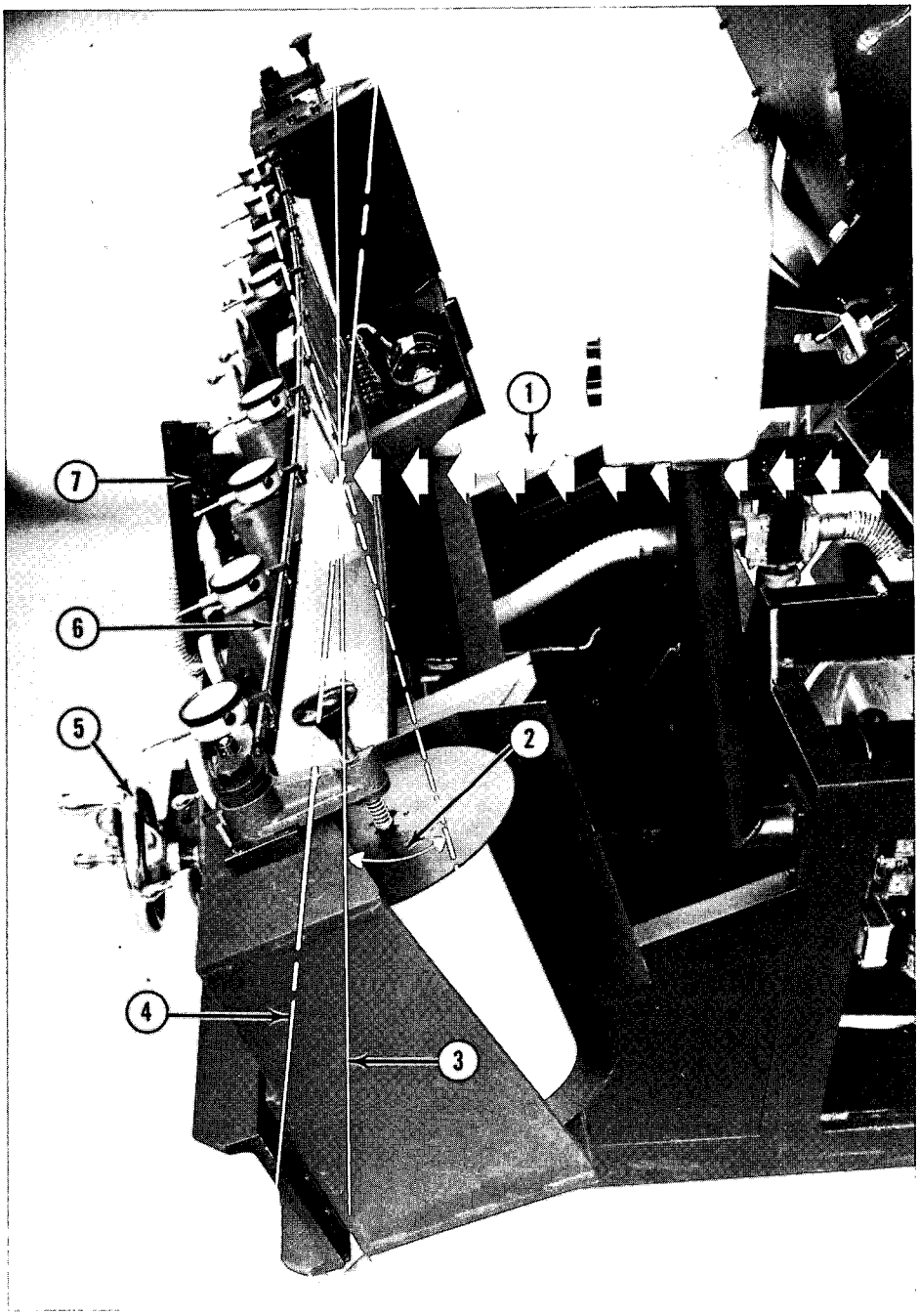
2-64. The takeup system consists of a torque motor (B101) and a drag brake. The torque motor is coupled to the takeup spindle so that it normally operates in a stalled condition, but will cause the spool to wind film as supplied by the drive roller during transport.

2-65. A similar drag brake is used at the supply side to prevent film spillage.

2-66. VACUUM SYSTEM. The vacuum turbine motor (B107) is constantly running during operation and vacuum is applied to the easel by means of solenoids L103 and L104. Solenoid L103 allows the air to go directly from the easel plenum to the turbine, while the vent solenoid (L104) is closed. When the relay circuitry reverses the positions of the solenoids, the vacuum solenoid (L103) is closed and the vent solenoid (L104) is open to the atmosphere, thereby releasing the film for a transport cycle.

2-67. The VACUUM switch (S104) is used to deenergize the vacuum solenoid valve (L103) and energize the vent solenoid (L104), thereby releasing vacuum from the easel as desired by the operator.

2-68. LIFE COUNTER OPERATION. The LIFE COUNTER (M101) is a six-digit, electromagnetic counter connected into the system so as to register one count each time an exposure cycle is performed by the printer. Because the counter cannot be reset, its reading is an actual record of operation over the life of the instrument.



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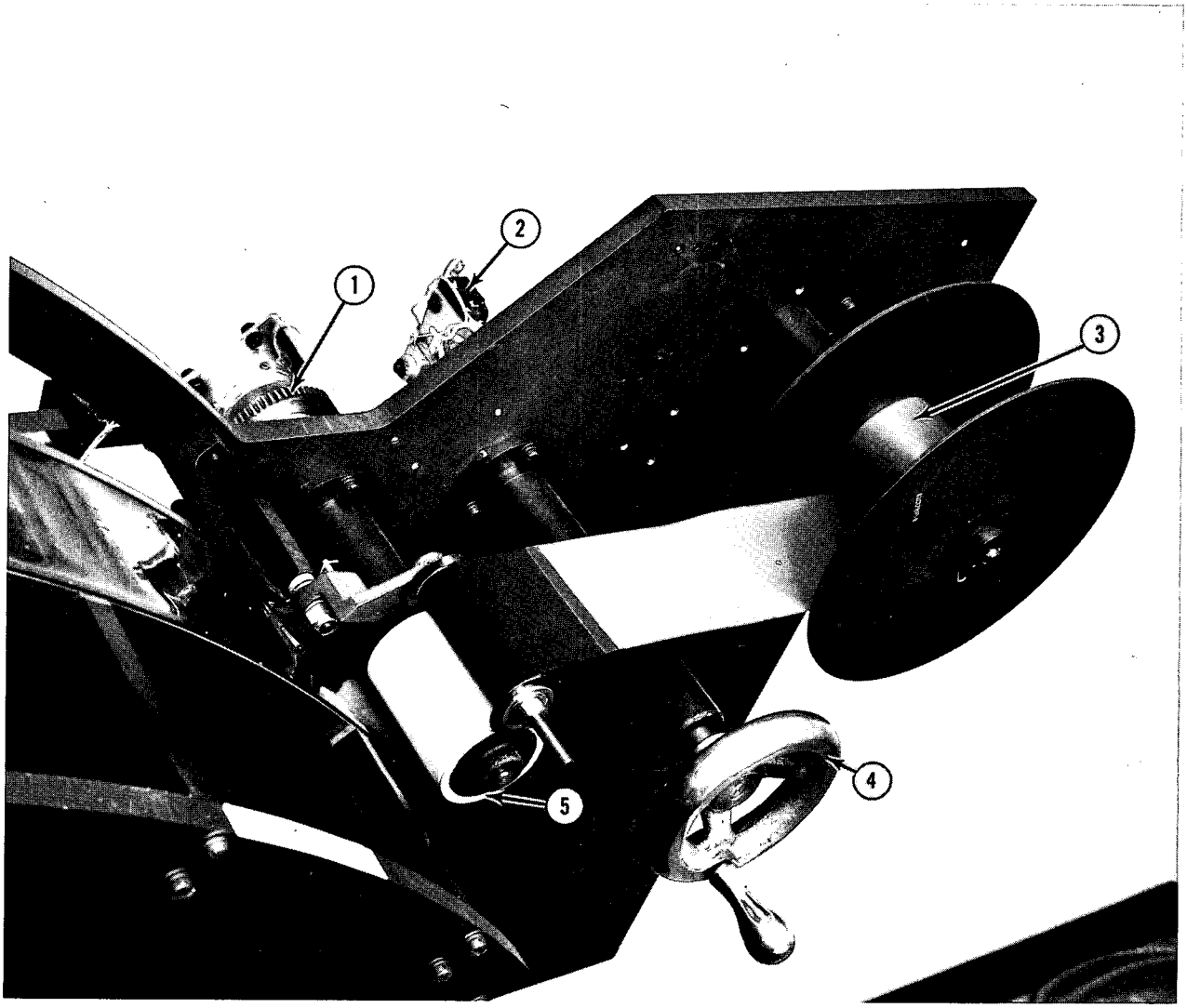
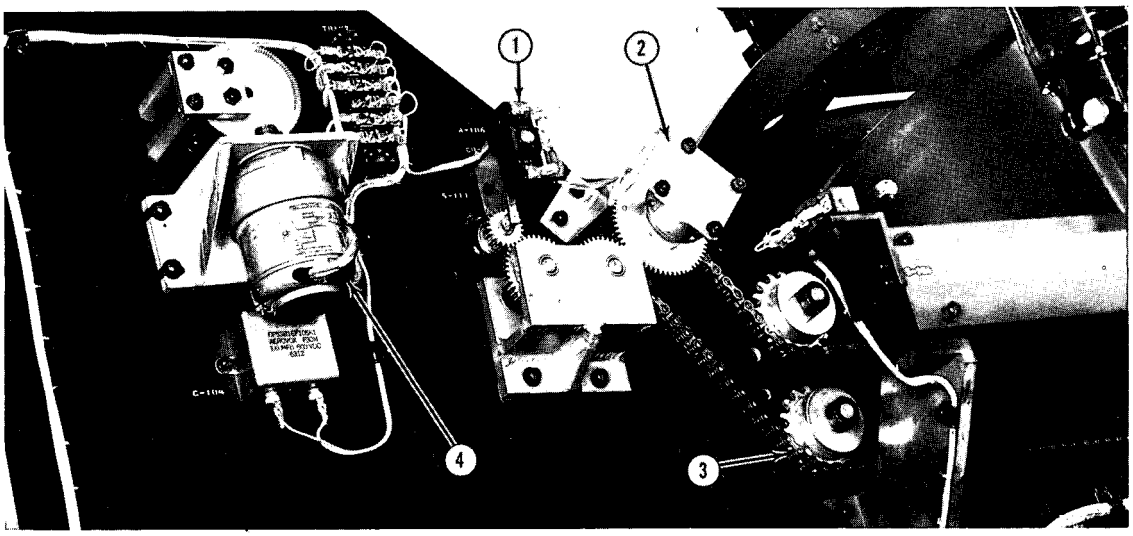
1 Projected beam
2 Tilt angle
3 Vertical reference
4 Tilt axis
5 Easel tilt control
6 Curved easel
7 Easel tilt indicator

Figure 2-1. Copy Easel Showing Tilt Axis



1 Magnetic locking brake
2 Brake control switch
3 Takeup spool
4 Drive handwheel
5 Drive roller

Figure 2-2. Negative Film Transport



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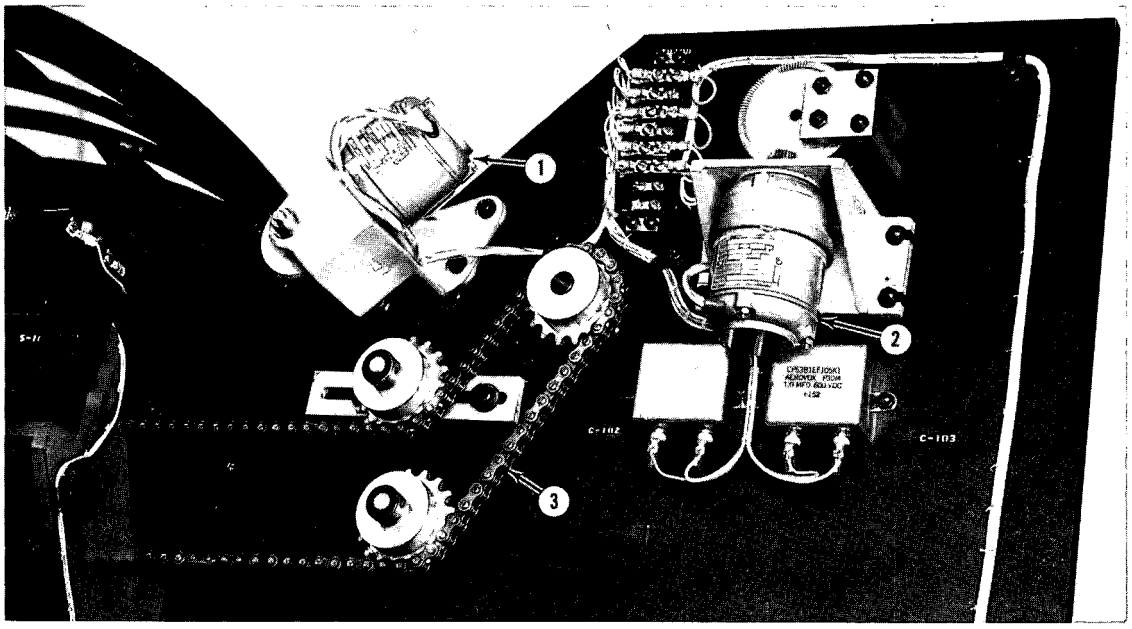
1 Brake control switch
2 Locking brake
3 Drive chain
4 Spool torque motor

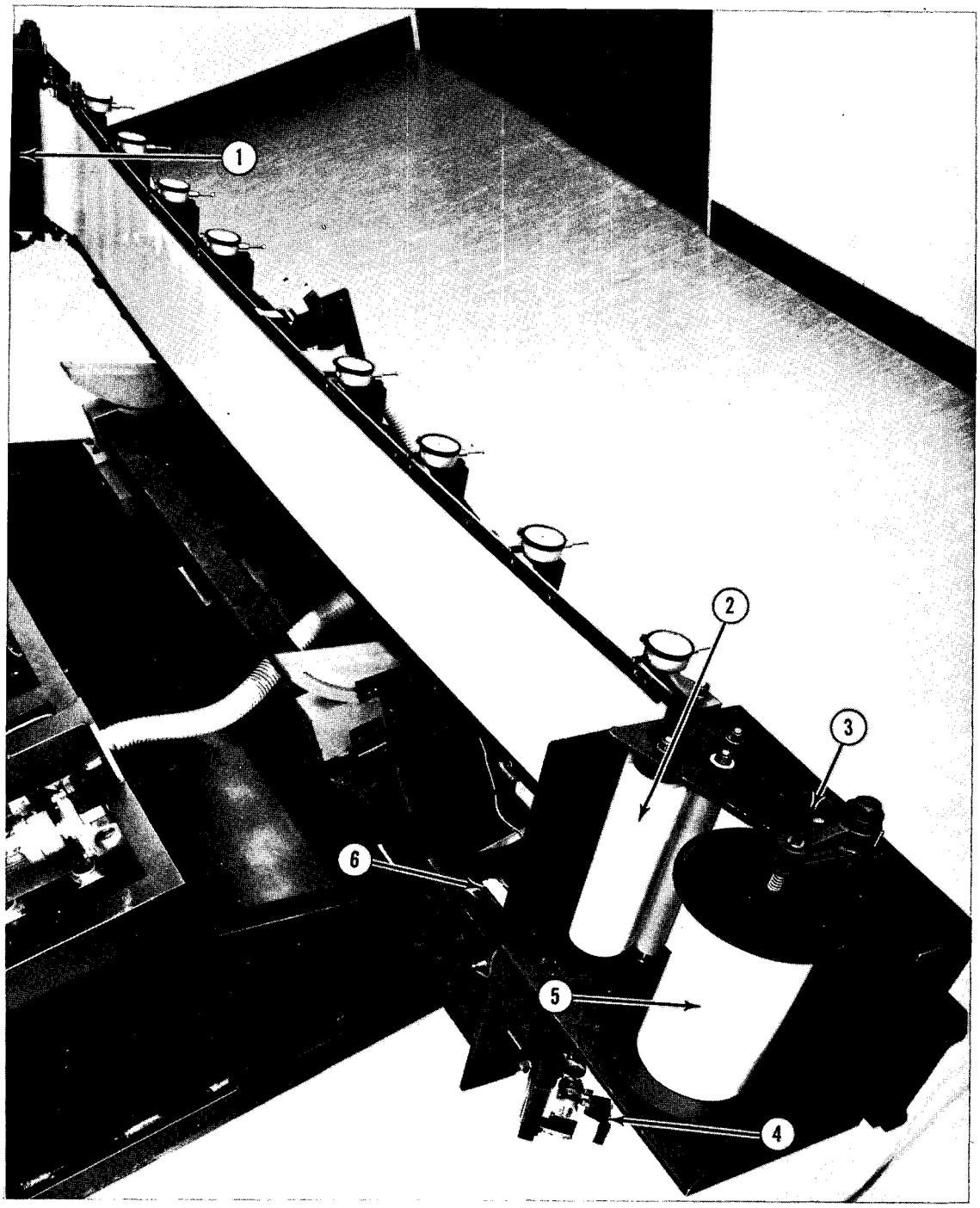
Figure 2-3. Negative Film Transport—Right Reverse Side



9883

1 Film tension torque motor
2 Spool torque motor
3 Drive chain

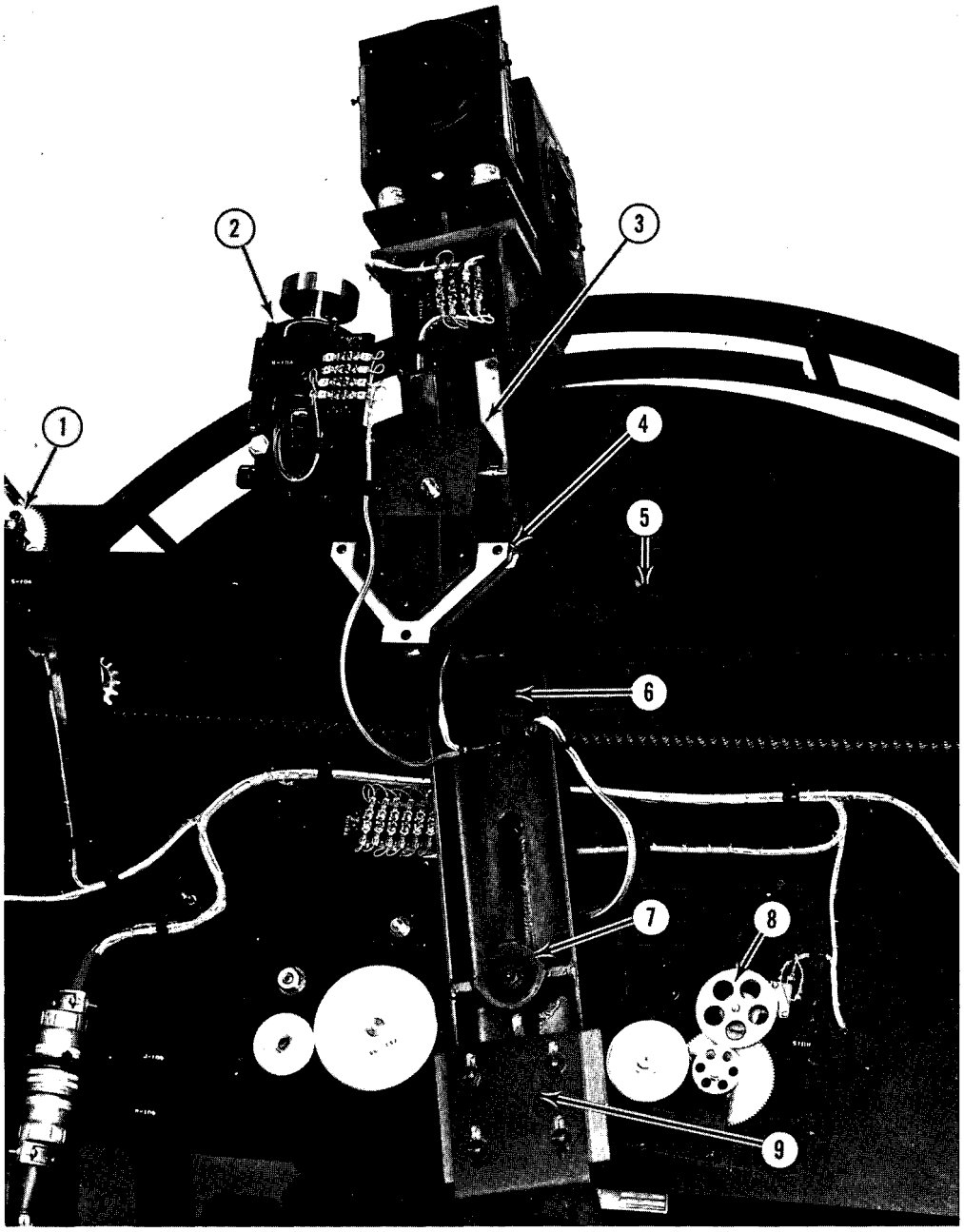
Figure 2-4. Negative Film Transport—Left Reverse Side



8091

1 Supply side
2 Drive roller
3 Locating handle
4 Variable speed control
5 Takeup spool
6 Drive motor

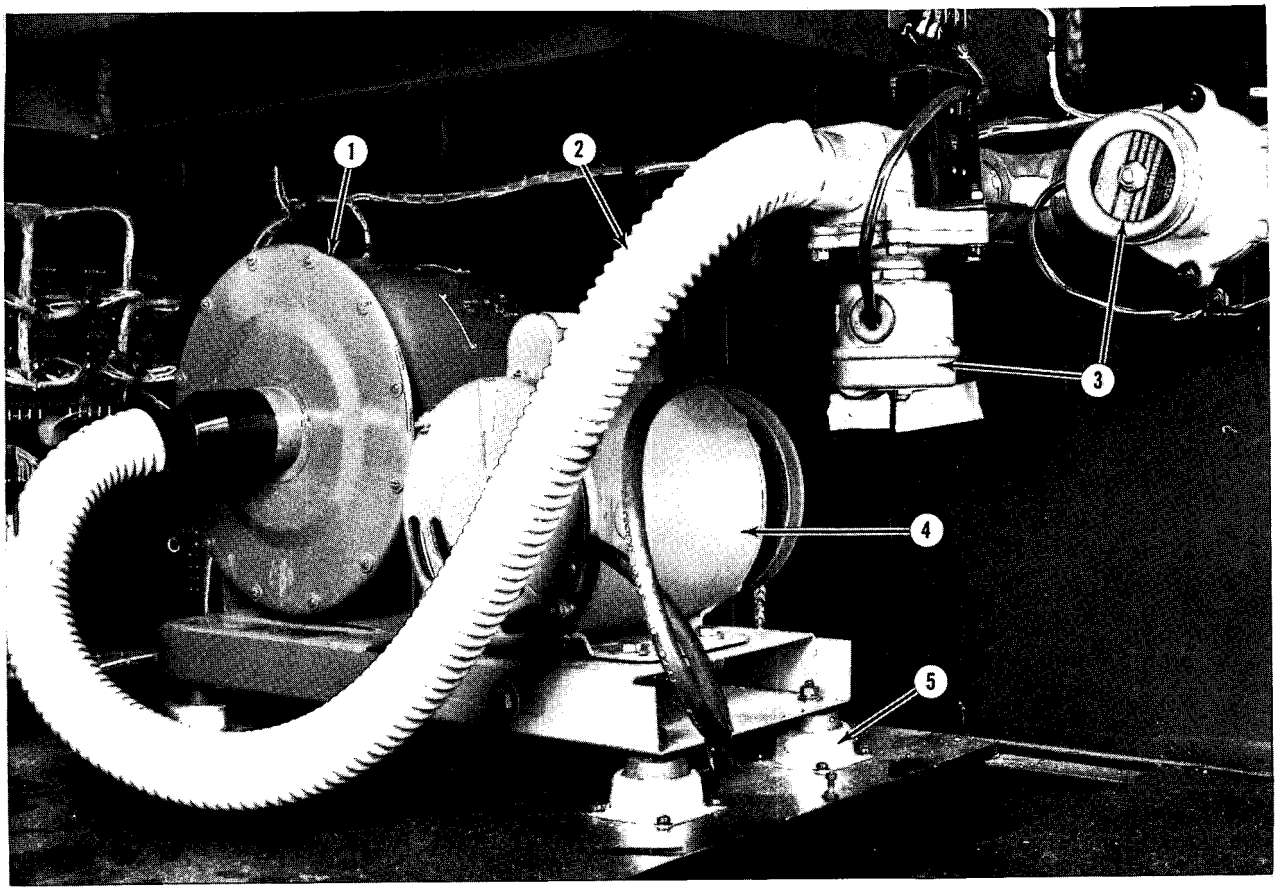
Figure 2-5. Copy Film Transport



9884

1 Limit switch
2 Drive motor
3 V ways
4 Guide wheel
5 Drive track
6 Drive arm
7 Drive arm pivot
8 Exposure control
9 Counterweight

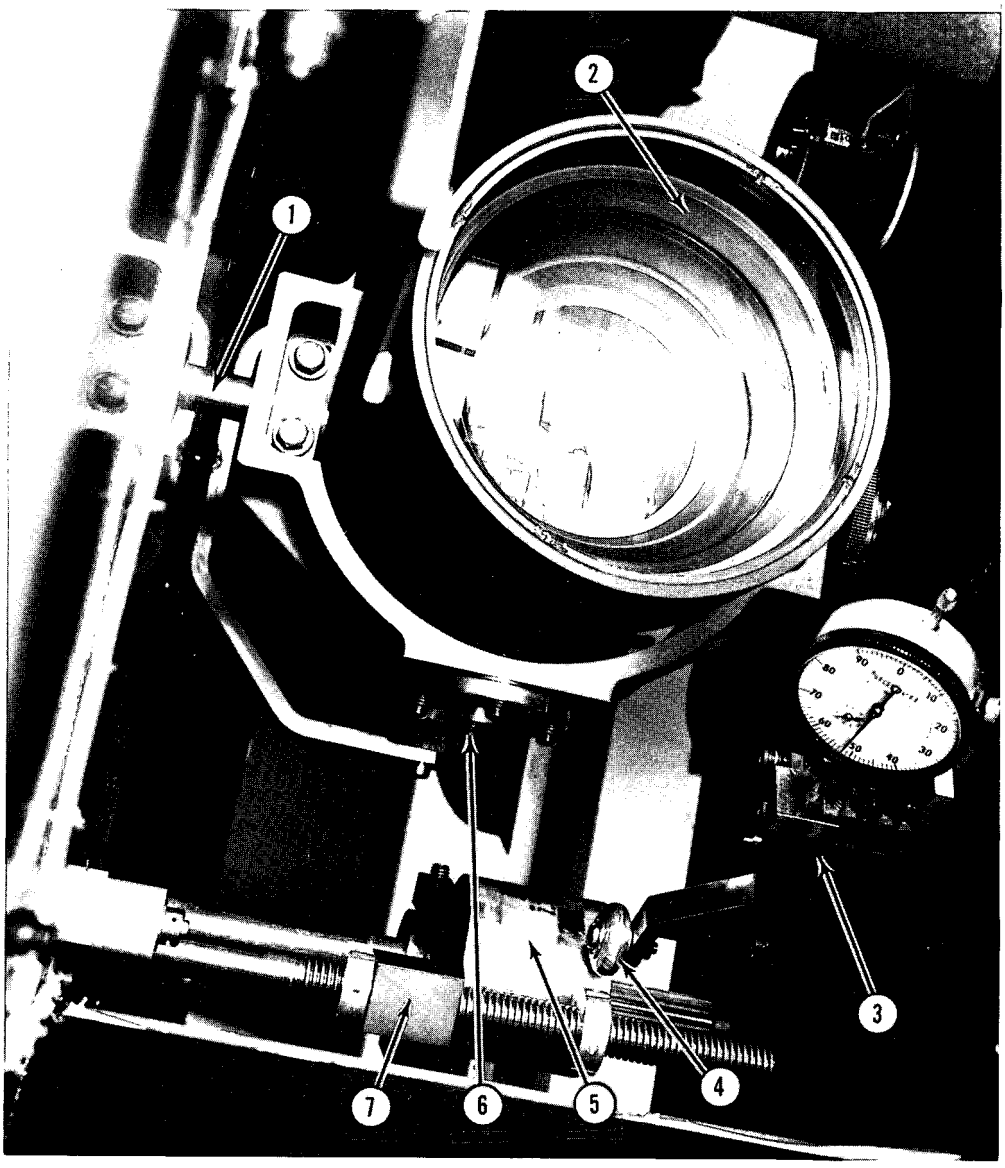
Figure 2-6. Scan Arm and Drive Assembly



8077

1 Vacuum pump
2 Vacuum hose
3 Vacuum solenoids
4 Vacuum motor
5 Vibration isolators

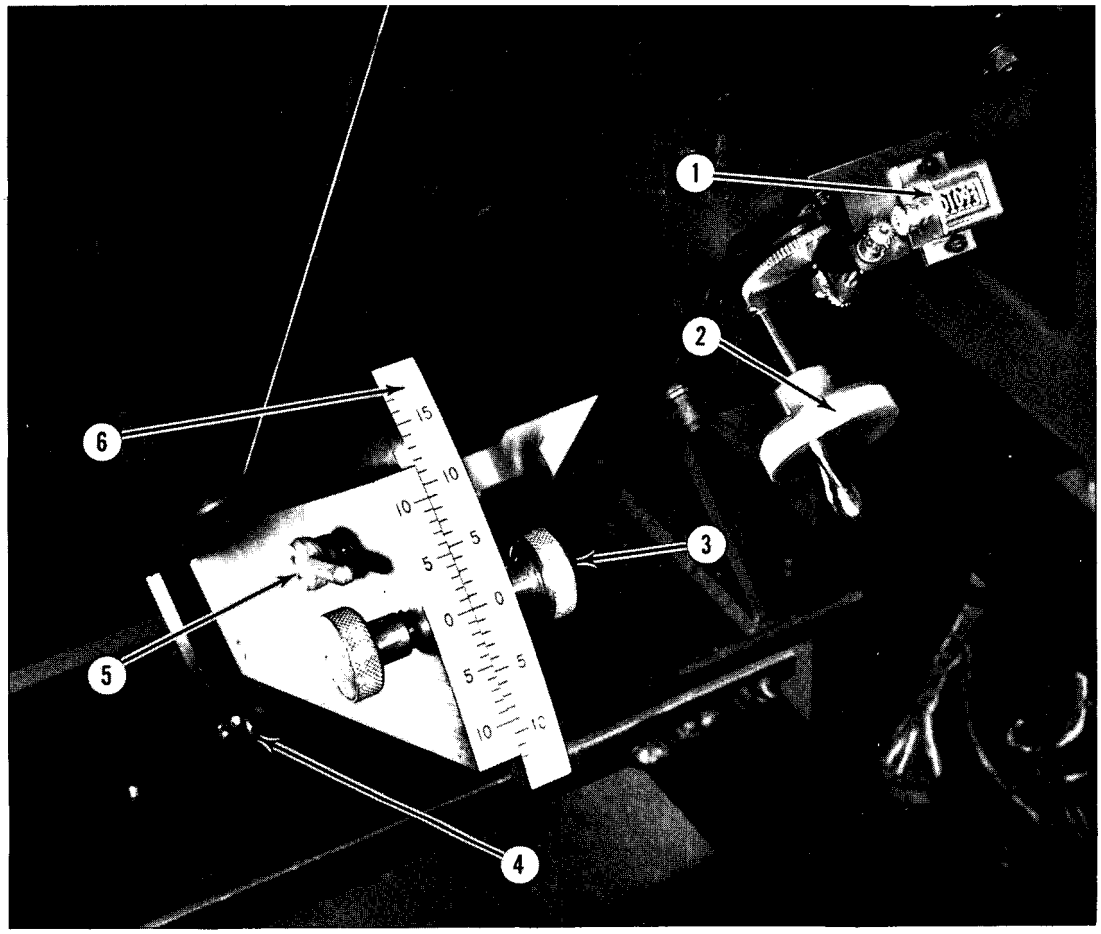
Figure 2-7. Vacuum System



9886

1 Focus control axis (γ axis)
2 Lens
3 Rack
4 Cam follower
5 Focus cam
6 Scheimpflug control axis
7 Cam translation control (shown disengaged)

Figure 2-8. Lens and Focus Cam



8079

1 Focus indicator
2 Focus control
3 Scheimpflug control knob
4 Control linkage
5 Lock
6 Scheimpflug indicator

Figure 2-9. Scheimpflug Control and Indicator

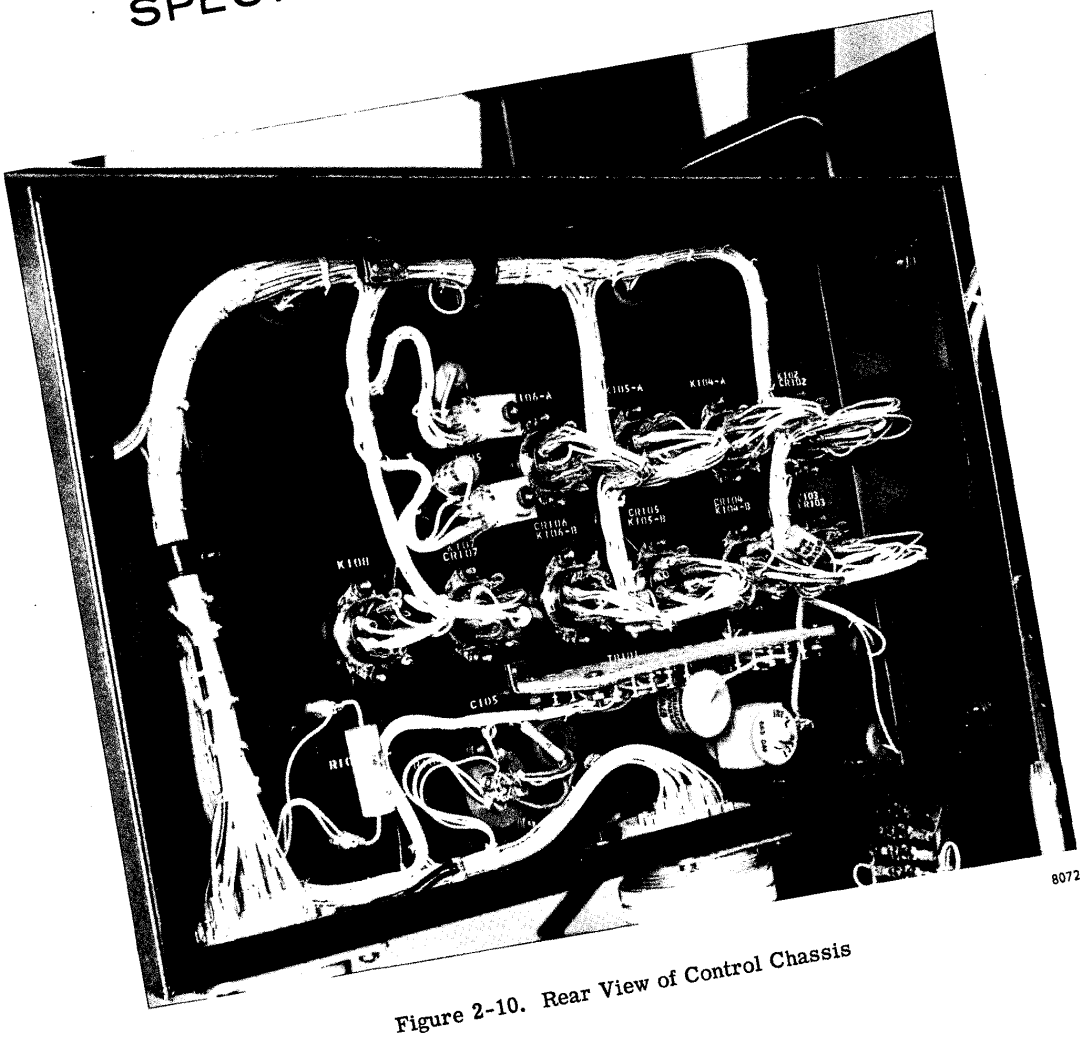


Figure 2-10. Rear View of Control Chassis

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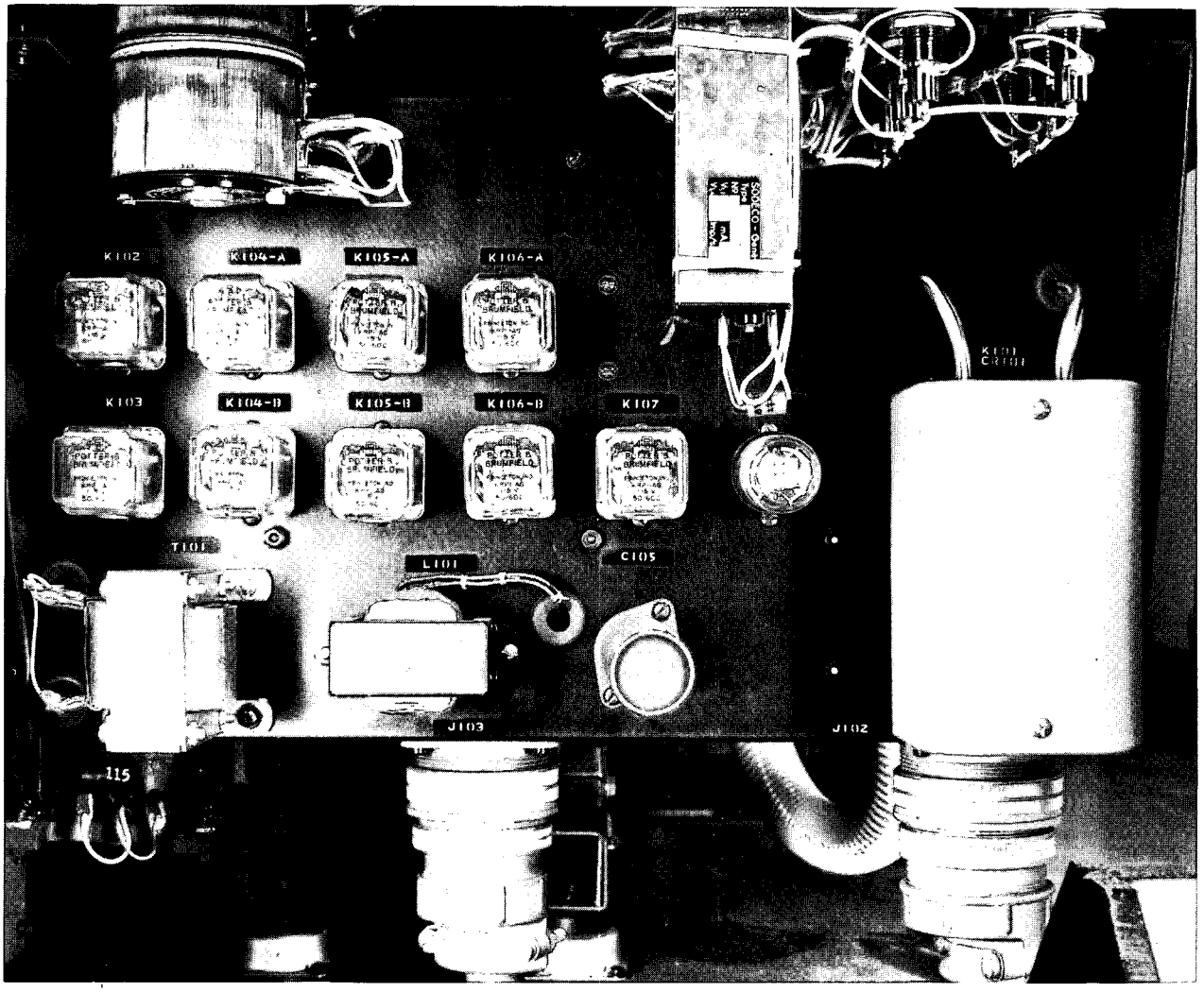

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Figure 2-11. Front View of Control Chassis

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STAT

SECTION III

CONTROLS AND OPERATION

3-1. CONTROLS.

3-2. The controls are located at various positions on the Gamma I Rectifying Printer. Those controls which govern the operational functions are located on the control panel, which is located at the right above the easel. Those that serve to set up and/or adjust the instrument are conveniently located near the mechanisms they control.

3-3. CONTROL PANEL. The following is a list of controls located on the panel (figure 3-1) and a description of the function of each.

a. The POWER switch is used to energize and deenergize all of the electrical circuitry of the printer.

b. The CONTROL PANEL ILLUMINATION rheostat varies the voltage to control the intensity of the dial lights.

c. The PROJECTION LAMP VOLTAGE control is a two-position (NORM and HIGH) switch. It selects either of two predetermined projection lamp voltages as required by the general density level of the input negative film. This control is a component of the instrument's exposure control system.

d. The SCAN TIME control is a variable transformer located on the control panel. The face of the panel, concentric about the control knob, is marked in increments from 0 to 100. This control varies the base voltage of the scan drive motor transformer and hence it partially controls the photographic exposure.

e. The PRINT control is used to initiate the automatic exposure and transport cycle.

3-4. FOCUS CONTROL. The focus control (figure 2-9) consists of a handwheel and a five-digit counter, both located on the lower right front surface of the main support plate. This control positions the three-dimensional focus cam in accordance with the stated altitude of the negative frame. The counter reading indicates the setting in kilofoot increments.

3-5. SCHEIMPFLUG CONTROL. The Scheimpflug control (figure 2-9) consists of two rotatable control knobs, a locking mechanism, and a vernier scale indicator. Either of the control knobs adjusts the position of the lens around the Scheimpflug axis, and the locking mechanism maintains the selected position. The indicator shows the Scheimpflug angle within 0.10 degree.

3-6. EASEL TRANSLATION CONTROL. The easel translation control (figure 3-2) is a manually operated crank located at the lower right front of the instrument. It is equipped with a micrometer collar indicator graduated in 0.001-inch increments, and translates the easel forward and backward in a line parallel to the floor to give the correct projection conjugate for the established tilt angle.

3-7. EASEL TILT CONTROL. The easel tilt control (figure 3-2) consists of a handwheel, located at the right of the easel translation control, and a scale type indicator, located at the center of the easel plate. This control rotates the easel in its tilt trunnions to the required tilt angle. The tilt indicator is calibrated in 0.10-degree increments. The tilt control is operated in conjunction with the easel translation control to settings established by the taking altitude and tilt angle.

3-8. EASEL CURVATURE CONTROL. The easel curvature control (figure 3-2) consists of eight handwheels and eight dial indicators. The handwheel and indicator subassemblies are evenly spaced from nadir along the top rear surface of the easel plate. The handwheels vary the easel curvature locally. The indicators show the local variation of curvature, from an established norm, in 0.001-inch increments. The curvature controls are positioned to settings established by the taking altitude and tilt angle.

3-9. NEGATIVE FILM TRANSPORT CONTROL. The negative film transport control (figure 2-2) is a handwheel located on the top outer surface of the support plate at the operator's right. When the handwheel is pushed in, it engages with the drive roller gear train and releases the magnetic brake. Rotation of the handwheel causes the film to be transported in the direction of rotation. When the control is allowed to snap out, it is automatically disengaged from the drive train and the magnetic brake locks the drive roller.

3-10. 70 MM TENSION CONTROL. The 70 MM TENSION control is a Powerstat variable transformer connected to the negative film tension torque motor power line. This control, located on the top panel of the control chassis (figure 3-3), varies the torque motor voltage, and consequently, the negative film tension over the platen. This control should not be used indiscriminately.

3-11. SLIT WIDTH CONTROL. The slit width control (figure 1-2) is a lever located at the lower end of the projection light housing. It is free to move in a plane perpendicular to the film support axis. When the lever is pushed all the way in, the slit width is at its maximum. When it is pulled all the way out, the slit width is at its minimum. This component is part of the instrument's exposure control system. Resolution is optimized with the slit opened to 1 millimeter.

3-12. COPY FILM METERING CONTROL. The copy film metering control is an integral component of the film drive speed control (figure 2-5) located at the lower left of the easel assembly. This lever controls the drive motor velocity, and hence the length of film transported during the automatic, timed cycle.

3-13. VACUUM CONTROL. The VACUUM control (figure 3-3) is a two-position (ON-OFF) toggle switch located on the top panel of the control chassis. It is connected to the vacuum solenoid valve so that it can override the automatic vacuum switching circuitry for making local adjustments to the copy film at the easel.

3-14. RESET SWITCH. The RESET switch (figure 3-3), located on the control chassis, is used in the event of a power failure during a scan cycle. Depressing the RESET switch after power has been restored allows the scan arm to return to a stored position, thereby readying it for the start of a new cycle.

3-15. SLIDE RULE.

3-16. Specialized individual slide rules have been designed and fabricated for the Gamma I Rectifying Printer. This slide rule converts the input taking parameters into actual machine settings for Scheimpflug angle, easel tilt, easel translation, and easel curvature. The settings are transmitted to the operator along with the film so that he may make his adjustments directly.

3-17. The slide rule consists of two fixed members, an index slide, and a movable indicator. One side of the rule has three scales on each of the fixed members and two scales on the index slide. The upper fixed member is used to obtain values for tilt angles between 0 and 6 degrees. The lower fixed member is used for values between 10 and 20 degrees. Values between 6 and 10 degrees are not included so as to keep the slide rule within workable proportions.

3-18. The scales on the upper and lower sections are marked to correspond with easel conjugate setting, d_0, lens Scheimpflug setting, ϕ, and tilt angle, t. The index slide has two scales to correspond with the flight altitude, H.

3-19. The reverse side of the slide rule will have two scales on the upper fixed member, three scales on the lower fixed member, and two scales on the index slide. The upper scales are used to obtain values for setting easel curvature at locations R_{10} and R_{20}. The lower scales are used for values of R_{30} and R_{40}, as well as the flight altitude, H. The index will be used for values of easel conjugate, d_0, and tilt angle, t.

3-20. EQUIPMENT OPERATION.

3-21. SLIDE RULE SETTINGS. Slide rule settings to be used by the operator in adjusting the printer for each frame are determined as follows.

a. To determine the easel tilt angle, t′, the lens Scheimpflug tilt angle, ϕ, and the easel conjugate setting, d_0, from the input parameters of primary tilt angle, t, and flight altitude, H, use the following procedure.

1. Position the index of the appropriate H scale opposite the given tilt angle on the appropriate t scale.

2. Move the indicator and position the center mark at the given flight altitude on the appropriate H scale.

3. Read the easel tilt angle, t′, from the appropriate t scale.

4. Read the lens Scheimpflug angle, ϕ, from the appropriate ϕ scale.

5. Read the easel conjugate setting from the appropriate d_0 scale.

b. To determine the indicator settings for controlling the easel curvature, use the reverse side of the slide rule and apply the following procedure.

1. Position the index of the easel conjugate setting scale, d_0, at the given value on the H scale.

2. Position the indicator at the previously determined value of easel conjugate setting on the d_0 scale.

3. Position the index of the t scale at the indicator centerline.

4. Position the indicator at the given value of tilt angle, t.

5. Read the values of R_{10}, R_{20}, R_{30}, and R_{40} from the appropriate scales at the centerline of the indicator.

3-22. EXAMINING NEGATIVE FILM. Negative film is examined in accordance with the following procedure.

a. Reduce the negative film taking parameters to instrument settings by using the slide rule as described above.

b. List the settings on a data sheet with reference to specific frames.

c. Take a density reading of each negative frame, using a densitometer, and determine an average value.

d. Transmit the film and the related data sheet to the printer operator.

3-23. STARTING PROCEDURE. The printer is started in accordance with the following procedure.

a. Connect the printer to a 115-volt, 60-cycle, single phase, 20-ampere power source by means of the power cord provided.

b. Press the POWER switch.

NOTE

Make certain the vacuum motor is connected to its proper receptacle (J109).

3-24. LOADING NEGATIVE FILM. Load the 70-millimeter negative film spool onto the supply spindle and thread it through the transport path in accordance with the loading diagram (figure 3-4) and the following instructions.

NOTE

The spools must be standard type MS26565-5.

a. Remove the locking collar from the spindles.

b. Place a full spool on the supply side, at the right of the instrument, and an empty spool on the takeup side, at the left of the instrument (as viewed from the front).

NOTE

Make certain that the spool on the left will unwind in a counterclockwise direction, while the spool on the right will unwind in a clockwise direction.

c. Reinstall the locking collars, making certain that the locking spring in the collar is engaged with the groove in the spindle.

d. Thread the film through the transport path so that the emulsion faces away from the lens and the data block is located at the rear of the instrument, thereby allowing the data to be projected through the system at the cutaway portion of the rear track.

CAUTION

Make certain the nadir offset indicator does not interfere with the film in the platen area.

e. Fasten the film to the core of the takeup spool.

f. Use the handwheel to transport the film until the desired frame is in the exposure area.

g. Set the nadir offset indicator to the roll setting indicated on the data sheet and align the frame fiducial mark with the pointer. To facilitate alignment, use the viewing glow lamp as follows.

1. Pull the glow lamp lever down to place the lamp in position. The lamp will illuminate automatically.

NOTE

Moving the glow lamp into position activates a switch which prevents initiation of a scan cycle. The lamp must be returned to its storage position to allow the equipment to resume an operational state.

2. Push the glow lamp lever up to return the lamp to the storage position.

3-25. LOADING COPY FILM. Load the 9 ½-inch copy film onto the supply spindle on the right, and thread it through the transport path and onto the takeup spool on the left in accordance with the loading diagram (figure 3-5) and the following instructions.

a. Lift the locating handle (figure 2-5) and rotate it until the pin engages the top surface of the arm, thus placing the handle in a stored position.

b. Load a spool containing 500 feet of 9 ½-inch copy film, positioning the lower flange of the spool on the spindle so that the two lugs are engaged.

NOTE

The spools must be standard USAF type 51C17848-12.

c. Release the locating handle so that the conical end engages the center hole in the upper flange of the spool.

NOTE

The supply spool must unwind in a clockwise direction.

d. Thread the film around the idler rollers, through the film guides, and across the copy easel; then thread it through the idler rollers, over the drive roller, and onto the takeup spool so that it will wind in a clockwise direction.

CAUTION

Do not move the drive roller. Movement of the roller will alter the timing sequence.

e. Fasten the film to the core of the takeup spool.

f. Initiate as many scan cycles as necessary to remove fogged film from the exposure area.

g. Check the metering response and adjust the drive motor speed control as required.

3-26. EQUIPMENT SETTINGS. Equipment settings are determined as follows.

3-27. Tilt Compensation. Compensate for tilt by observing the following procedures.

a. Set the easel tilt control to the angle specified on the film data sheet.

b. Adjust the Scheimpflug control to the angle specified on the film data sheet and lock it in place at this setting.

c. Operate the easel translation control to move the easel to the position indicated on the film data sheet.

NOTE

When translating the easel, move it to a point beyond the desired setting by rotating the handle in a counter-clockwise direction; then return to the correct setting by rotating the handle clockwise.

3-28. Altitude Compensation. Adjust for altitude compensation in accordance with the following procedure.

a. Set the focus (altitude) control to the reading specified on the film data sheet.

b. Adjust each of the easel curvature controls to the settings specified on the film data sheet.

3-29. EXPOSURE. Exposure is accomplished in accordance with the following procedure.

a. Adjust the exposure control system to the optimum setting for the mean density of the negative film as indicated on the film data sheet. This is accomplished by setting the following.

1. Scan arm velocity.
2. PROJECTION LAMP VOLTAGE control.
3. Slit width control lever.

b. Activate the PRINT switch to initiate the automatic exposure and transport cycle.

c. After the desired number of prints has been made (one print per operation of the PRINT switch), transport the negative film to the next significant frame.

d. Make whatever adjustments are indicated on the film data sheet before exposing the next frame.

3-30. SHUTDOWN.

3-31. Shutdown of the Gamma I Rectifying Printer is accomplished in accordance with the following procedure.

a. Depress the POWER switch.
b. If the instrument is to remain inactive for a period of time, remove all film.

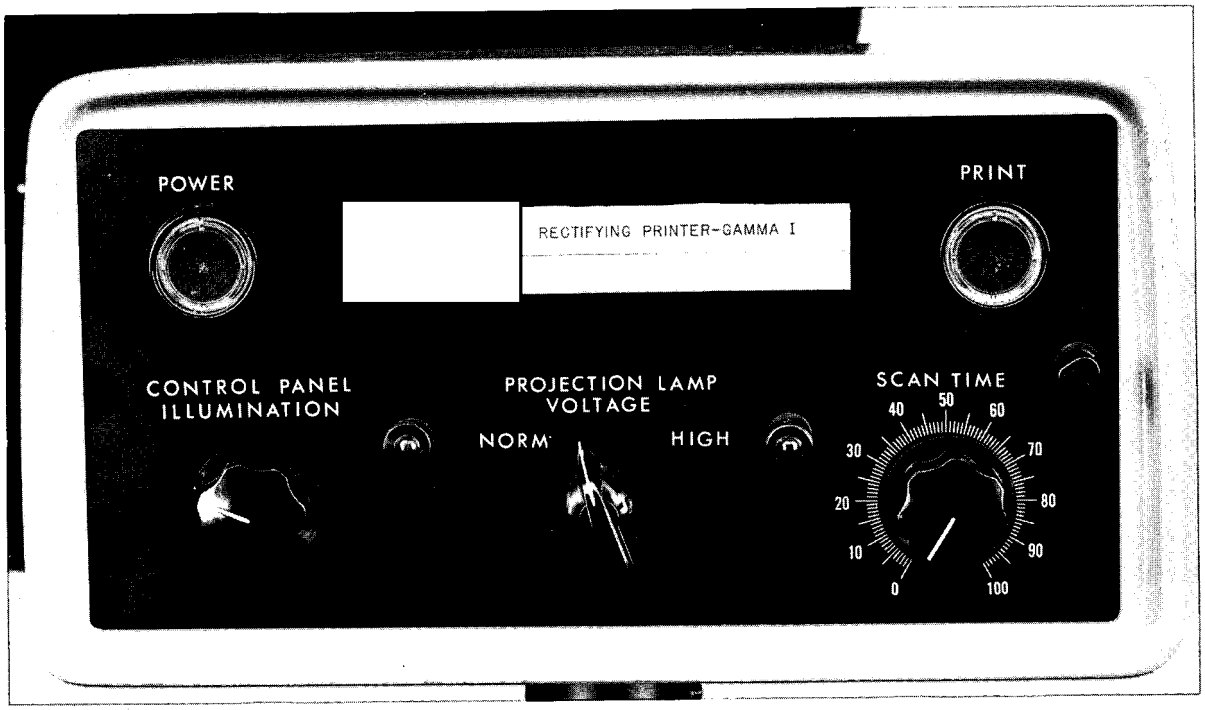

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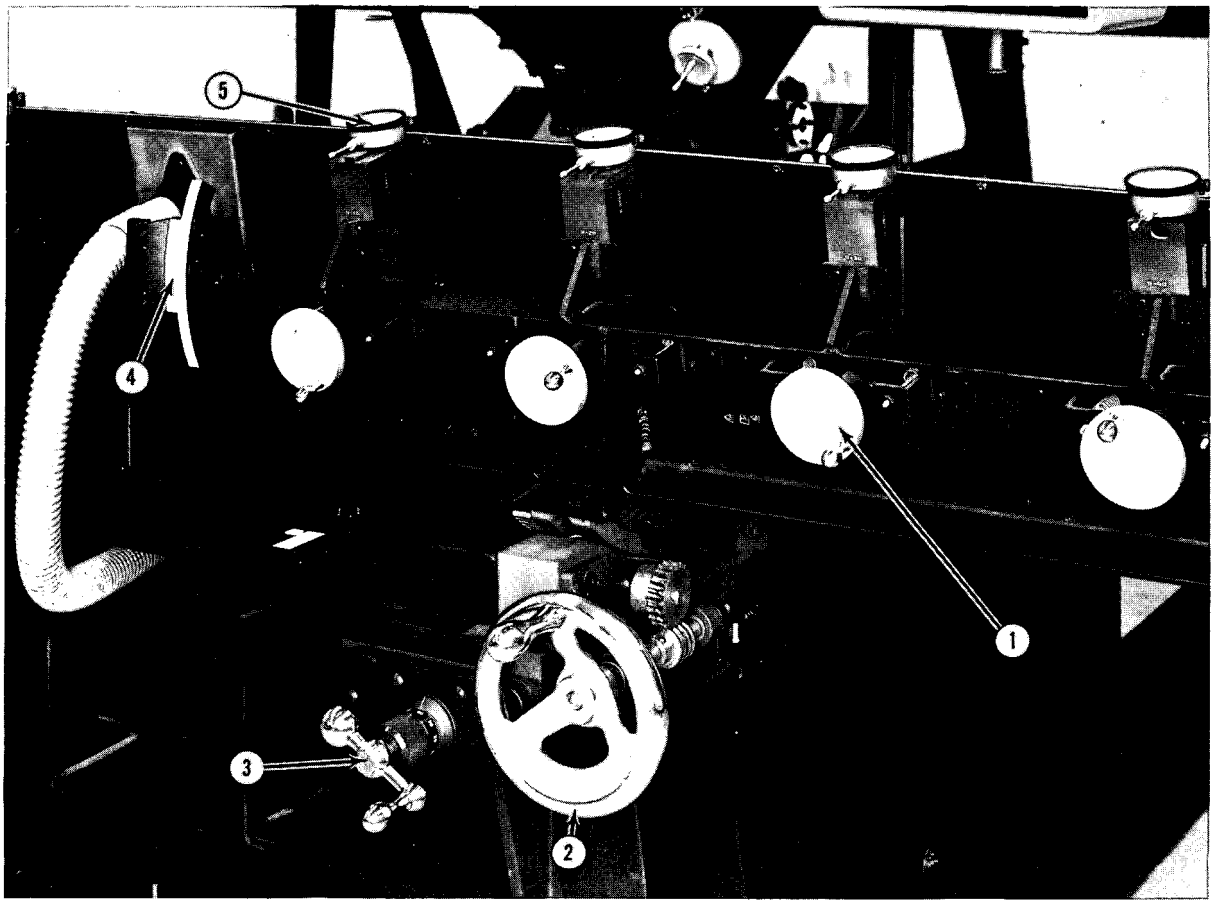
Figure 3-1. Control Panel



9879

1 Curvature control
2 Tilt control
3 Translation control
4 Tilt indicator
5 Curvature indicator

Figure 3-2. Easel Translation, Tilt, and Curvature Controls

8078

Figure 3-3. Top Panel of Control Chassis

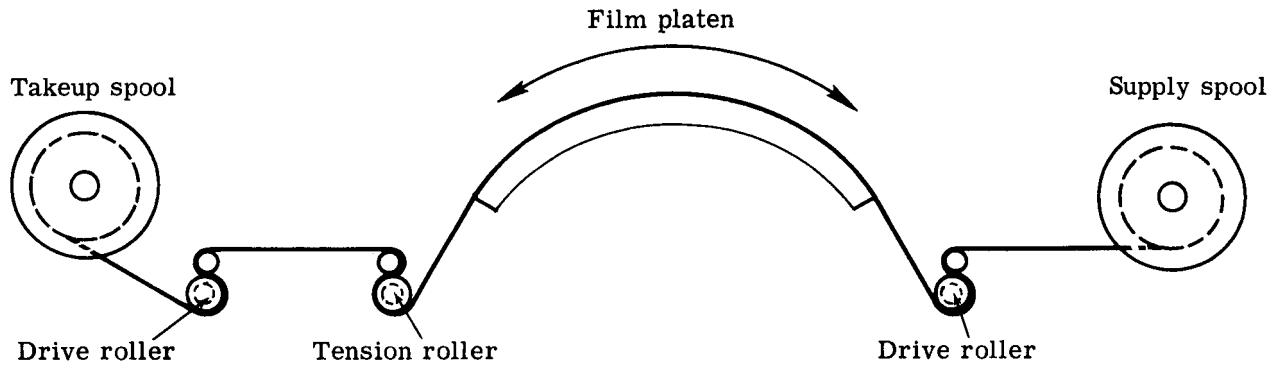


Figure 3-4. Loading Diagram for 70-Millimeter Negative Film

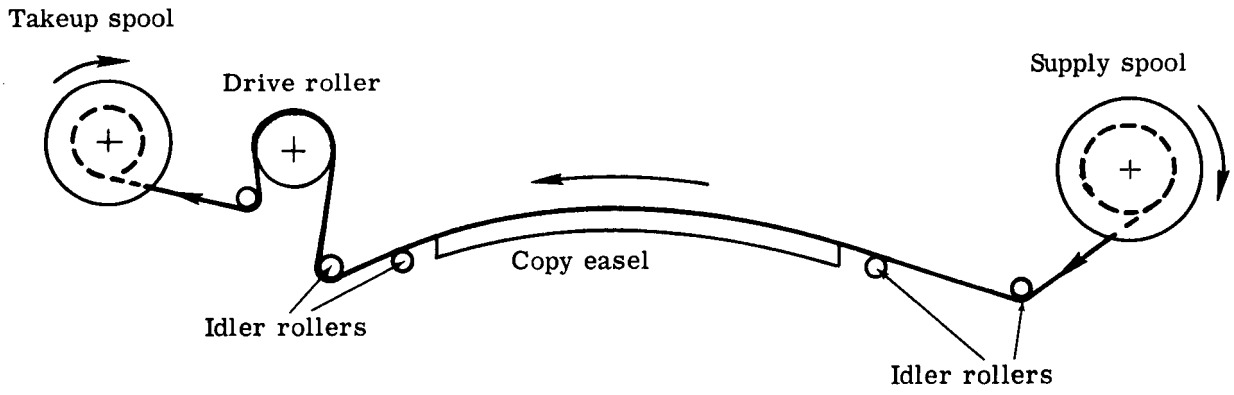


Figure 3-5. Loading Diagram for 9½-Inch Copy Film

SECTION IV

MAINTENANCE

4-1. GENERAL.

4-2. This section contains the preventive and corrective maintenance procedures recommended for the satisfactory performance of the Gamma I Rectifying Printer.

4-3. PREVENTIVE MAINTENANCE.

4-4. Preventive maintenance consists of periodic inspection, cleaning, and lubrication of the instrument.

4-5. INSPECTION PROCEDURE. Inspect the various components of the instrument in accordance with the instructions given in tables 4-1 and 4-2.

4-6. CLEANING PROCEDURES. If inspection indicates that cleaning is required, observe the following cleaning procedures.

NOTE

Extreme care should be exercised in the operation and handling of this instrument to ensure that the lens and mirror cleaning procedures are kept to an absolute minimum in order to avoid scratching the components.

4-7. Optical Surfaces.

a. Clean dust from surfaces with a high quality camel's hair brush. Brush with light strokes in one direction. Dust may be removed by use of clean air in aerosol cans, purchased commercially.

b. Clean haze, finger marks, and smudges from the lens surfaces with lens tissues and an approved lens cleaning solution (Mirolen is suitable) in the following manner.

1. Saturate a lens tissue with an approved cleaning solution.
2. Wet the entire surface by applying the solution gently with the saturated tissue.

CAUTION

Do not scrub the surface.

3. Dry the surface with a clean lens tissue.
4. Repeat the above procedures if necessary to ensure complete cleaning.

4-8. Mechanical Surfaces.

a. Remove dust from exposed surfaces with a soft brush.

b. Clean oil or grease deposits from components with MEK (methylethylketone)methanol, etc.

CAUTION

Do not use cleaning compounds that leave an oily residue.

c. Clean dust and dirt from corners and less accessible areas with a vacuum cleaner equipped with a fiber nozzle.

4-9. LUBRICATION. Lubricate the printer in accordance with the lubrication schedule given in table 4-3.

4-10. TROUBLESHOOTING. If the inspection performed in accordance with paragraph 4-5 or the operational responses of the instrument indicate the need for repair, alignment, and/or adjustment, consult the Troubleshooting Chart in Section V (table 5-1). Perform the appropriate corrective steps in accordance with the remedial instructions contained in the chart.

4-11. OPTICAL ALIGNMENT. Check the alignment of the printer in the following manner.

4-12. Alignment of Optical Axis with Easel.

a. Prepare a strip of 70-millimeter opaque film by scribing a centerline along the length of the film; the line should be about 30 inches long and 0.005 inch wide. The film strip should be about 10 feet long to allow proper threading and tension control over the platen.

b. Retract the scan arm friction drive wheel from contact with the drive track by loosening the three screws that secure the motor support to the carriage, and lift the motor assembly until the friction drive wheel is clear of the track; tighten the screws.

c. Position the nadir offset indicator at zero with the slide fully extended forward.

d. Manually position the scan arm at nadir.

NOTE

Connect a jumper cord from a 115-volt, 60-cycle source to TB112-2 and TB112-4 to allow the lamp fan to continue operation. This connection bypasses the normal electrical operation of the printer, and the circuit must be restored before normal operation. The louver mounted at the rear of the fan assembly should be removed during this period.

e. Activate the POWER switch.

f. Activate the PRINT switch. (This turns on the projection lamp.)

g. Observe the projection of the slit and the indicator line on the easel.

NOTE

A piece of white paper placed on the easel will facilitate observation of the images.

Table 4-1. Component Inspection Schedule

Item	Inspect For	Inspection Frequency
Optical components	Dust, dirt, smudges, etc.	Daily
All exposed surfaces	Dust, dirt, and/or moisture	Daily
Projection and indicator lamps	Proper illumination	Daily
Film spools	Damaged or bent flanges	When loading
Controls and mechanisms	Looseness or excessive friction	Weekly
Rollers and spindles	Alignment and free rotation	Weekly
Cables and wiring	Frayed or worn insulation, broken wires, loose joints, and dirty, bent or crowded contacts	Weekly
Entire instrument	Loose or missing hardware	Monthly
Exposure arm	Alignment	Monthly
Link chains	Stretching and/or wear	Monthly
Gears	Broken or worn teeth, proper mesh	Monthly

Table 4-2. Fuse Inspection

Number	Rating, amperes	Location	Function
F101	20	Control chassis	Main fuse
F102	1.25	Control chassis	70-millimeter transport motors
F103	1	Control chassis	9 1/2-inch takeup motor
F104	4	Control chassis	9 1/2-inch drive motor
F105	15	Control chassis	Vacuum motor
F106	1	Control chassis	Scan arm drive motor
F107	0.2	Control chassis	Cooling fan
F108	—	Control chassis	Spare

Table 4-3. Lubrication Schedule

Item	Lubricant	Lubrication Frequency
Gear trains	Lubriplate	Monthly
Motors	Permanently lubricated	—
Easel and scan arm V-ways	Lubriplate	Monthly
Vacuum turbine	Lubriko M-6	Every 1,500 to 8,000 hours

h. Center the projected slit on the indicating line by moving the scan arm.

i. Clamp the arm at this position by locating stops at either side of the arm. Do not deflect the scan arm by clamping directly to the base plate. Check that the alignment has not changed during the clamping operation.

j. Activate switch S105 or S106 manually. Wait until the 9 ½-inch film transport system completes its cycle; deactivate the POWER switch. This will turn off the projection lamp by removing power from the equipment.

k. Position the opaque film strip over the input platen.

l. Reduce the width of the projection slit to 1/2 millimeter or less.

m. Activate the POWER switch.

n. Activate the PRINT switch.

o. Observe the image of the intersection of the slit with the scribed line; this will appear as a small dot of light. This image should be exactly at the center of the easel, which can be verified by measurement in the vertical direction and by observation of alignment with the central vent holes in the easel plate.

p. Position the point of light at the center of the easel by moving the folding mirror in the proper direction to obtain alignment.

q. Rotate the easel translation control so that the easel travels its full range of conjugate settings. Observe that the point of light remains at the center of the easel. (The size of the image will increase as the easel moves from the plane of sharp focus.)

r. Position the easel at the plane of sharp focus.

s. Rotate the easel tilt control, and observe that the image remains at the center of the easel. Any motion of the image indicates that the image does not intersect the easel at the rotational axis.

4-13. System Alignment (Double Line Test).

a. Scribe two lines at right angles to the length of a strip of 70-millimeter opaque film. The separation between the lines need not be accurately known, but they should be from 12 to 14 inches apart.

NOTE

Lines are used in this test rather than pinholes, which provide an equally valid test, only because it is easier to scribe two lines at right angles to the film edges than it is to locate two pinholes on a line accurately parallel to the film edge.

b. Position the film over the input film platen, and locate one of the scribed lines accurately at nadir.

c. Insert an 8-foot piece of exposed but undeveloped 9½-inch film in the easel.

d. Activate the VACUUM switch to maintain film flatness.

e. Set the Scheimpflug and easel tilt controls to zero.

f. Check that the scribed line is accurately at nadir.

g. Activate the POWER switch.

h. Activate the PRINT switch.

i. Mark the position of the image of the scribed line on the 9 ½-inch film.

j. Without disturbing the input film, rotate the scan arm until the second slit is projected onto the film at the easel. Mark the position of this image on the 9 ½-inch film.

k. Reset the scan arm to nadir.

l. Transport the input film until the second slit is accurately positioned at nadir.

m. Rotate the scan arm in the opposite direction and project an image of the slit which was previously at nadir. Mark the position of this image on the 9 ½-inch film.

n. Position the arm at nadir and check the central projected image.

o. Deactivate the VACUUM switch to release the vacuum at the easel.

p. Remove the 9 ½-inch film from the easel. Turn the film end for end, and reposition it on the easel.

q. Align the central mark on the film with the projected image, and activate the VACUUM switch to hold the 9 ½-inch film in place.

r. Repeat steps i through o above.

NOTE

This test is a sensitive check of the complete system alignment. Lack of symmetrical coincidence could indicate misalignment of the optical system or mechanical misalignment. Extreme care must be exercised during the above procedure to ensure proper analysis of the results. If symmetrical coincidence is not present, it will be necessary to adjust the equipment and retest. Equipment adjustment must be carried out by cognizant technical personnel.

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SECTION V

TROUBLESHOOTING

5-1. TROUBLESHOOTING CHART.

5-2. Table 5-1 lists various malfunctions that may be encountered in the operation of the Gamma I Rectifying Printer, along with the probable cause and corrective measures that may be taken to remedy the problem.

Table 5-1. Troubleshooting Chart

Malfunction	Probable Cause	Corrective Action
Control panel lamps not illuminated when POWER switch is actuated	Line cord not connected	Plug in connectors
	Indicator lamps burned out	Replace
	Fuse F101 blown	Replace after checking for obvious short circuits
	Relay K101 faulty	Replace
Viewing glow lamp (DS104) not illuminated when positioned under 70-millimeter film	Lamp faulty	Replace
	Switch S107 faulty	Replace
PRINT switch actuated, but printing cycle does not occur	Viewing glow lamp not in stored position	Place lamp in stored position
	Drive wheel not in contact with drive track	Make proper adjustment
	Switch S107 faulty	Replace
	Fuse F106 blown	Replace
Printing stops during a cycle	Switch S107 not fully released by cam	Adjust switch for proper action
	Fuse F106 blown	Replace
	Fuse F101 blown	Replace
	Line cord disconnected	Reconnect to power source

Table 5-1. Troubleshooting Chart (Cont.)

Malfunction	Probable Cause	Corrective Action
Projection lamp (DS103) does not illuminate during printing cycle	Lamp burned out	Replace
	Switch S103 faulty	Replace
	Transformer T104 faulty	Replace
	Relay K105-A faulty	Replace
Lamp housing heats up excessively during repeated operation	Lamp does not shut off at end of cycle	Replace relay K105-A or switches S105 and S106 as necessary
	Cooling fan B108 does not operate at completion of scan cycle	Replace fan, fuse F107, or relay D105-A, as necessary
Scan arm travels with an intermittent motion	Oil or grease inadvertantly spilled on drive track	Clean drive wheel and track
	Drive wheel not making proper contact with drive track	Adjust friction drive for proper contact
Copy film transport system does not transport correct amount of film	Drive system out of adjustment	Adjust speed control unit
	Vacuum not released at easel	Replace solenoid L103
	Fuse F104 blown	Replace
	Magnetic coupling and brake L102 not functioning	Replace
Copy film transport system does not operate at completion of scan cycle	Timing cams out of adjustment	Remove power from printer; rotate drive roller until cams are properly positioned; activate POWER switch; cycle machine to clear easel

SECTION VI

LIST OF PARTS

6-1. GENERAL

6-2. The following is a list of the assemblies of the Gamma I Rectifying Printer and their [ ] STAT drawing number.

Description	[ ] Drawing No. STAT
Main assembly	59100
Base plate assembly	59101
Easel mechanism assembly	59102
Film transport ($9\frac{1}{2}$- inch) assembly	59104
Control panel assembly	59105
Control chassis assembly	59106
Power cable assembly	59107
Frame harness	59108
Gamma I electrical schematic	59109
Light source assembly	59110
Film transport (70-millimeter) assembly	59111
Lens assembly	66416

SPECIAL HANDLING

SPECIAL HANDLING

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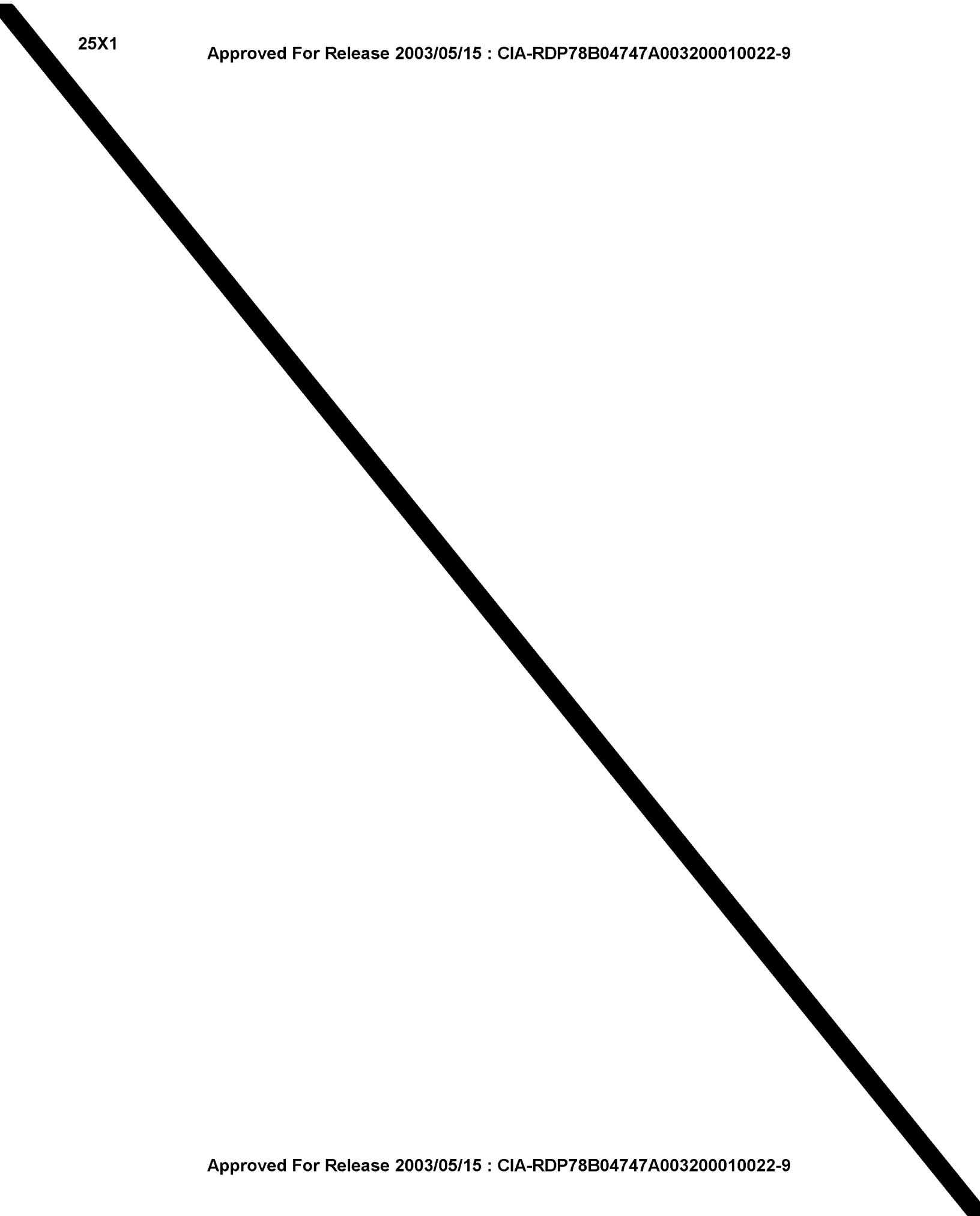

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